THE

ELECTRICAL REVIEW.

VOL. XXXIV. MAY 4, 1894. No. 858

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THE

UNIVERSAL ELECTRICAL DIRECTORY

(J. A. BERLY'S).

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1894 ISSUE.

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Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

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OFFICE:—22, PATERNOSTER ROW, LONDON.

Telegraphic Address "AGENRAY, LONDON." Code A B C. Telephone No. 517.

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BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

FOREIGN AGENTS.—New York: D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 22, Rue de la Banque. *Berlin:* ASHER & Co., 5, Unter den Linden.

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MUIRHEAD *v.* THE COMMERCIAL CABLE COMPANY.

THE judgment on this case, which was delivered last Saturday by Mr. Justice Kennedy, will, we believe, be a surprise to many, and although Messrs. Muirhead are to be congratulated on the result, it is one which it is difficult to agree with; only a most liberal interpretation of the meaning of one patent, and a restriction of the meaning of others, could, we think, have enabled the decision, such as it is, to be arrived at. It is a noticeable fact that the evidence of eminent men who have had no practical experience of the subject at issue has apparently been considered as of greater weight than that of those whose acquaintance with practical details has been extensive and close. The whole case was undoubtedly one which it was exceedingly difficult to make plain, but the remarkable grasp which Mr. Justice Kennedy appeared to obtain of the technical details as the case proceeded, makes his judgment more difficult to understand.

Although there were several points involved in the action, the issue of the case really turned on the question whether or not a certain American patent was or was not similar to a certain English patent, or rather whether or not the American patent was granted for an invention which had been patented in England four years previously. According to a principle laid down by Judge Cox in America, if there is any doubt about two patents being similar, the doubt should always be in favour of the two patents *not* being considered similar. This principle, said Mr. Justice Kennedy, is identical with English law. The claim of the 1880 patent (the American) was, in Justice Kennedy's judgment, a claim of the narrowest kind, effecting, as the patentee alleged, new and useful improvements in duplex telegraphy; there was no claim made for any of the structural elements of the combination beside the combination. Admittedly all these elements, taken separately, were old. The object of the 1876 (the English) patent was to obtain certain ends by certain novel combinations and organisations of instrumentalities. The defendants had to show that the particular combination of old instrumentalities—the working of which undoubtedly had produced better results than had ever been obtained before—was to be found in the English patent. "He (Mr. Justice Kennedy) was satisfied by the evidence of Lord Kelvin, Dr. Bottomley, Prof. Silvanus Thompson, and Dr. Hopkinson, that the introduction of the rheostat alone, placed at the apex of the arms of the bridge, and therefore in such a position as not merely to afford an easy and sufficient means of varying resistance, so as to get a ratio which gave a balance, but also to maintain the sum of the resistances of the two bridge arms constant, was a very important part of the 1880 combination. He did not find any combination containing that element in the patent of 1876. The battery, the key, the receiving instrument and its con-

densers—all these were to be found in the 1876 patent—but he did not find there was any means and method of adjustment which, in his opinion, formed the important part of the patent of 1880. On the contrary, he found in the 1876 patent means of adjustment of a much more clumsy and complicated nature, which were incompatible with the use of a low resistance rheostat." It will be noted that his Lordship lays great stress upon the rheostat being *an important part* of the 1880 patent, and moreover he says "the working of which undoubtedly had produced better results than had ever been obtained before"; how this conclusion was arrived at we are unable to see, the condensers, not the rheostats, improve the working. Doubtless the eminent men who gave evidence for the plaintiff believed, and made his Lordship believe, in the importance of the rheostat, although they had no practical experience whatever on the subject, yet it seems strange that their theoretical evidence should be allowed to preponderate against the practical evidence of experts, who stated that they knew, not from theory, but actual acquaintance with the apparatus and from experiment—an ounce of which is worth a pound of theory—that the rheostat did not act as it was stated to do. One point which may have misled the Court, and which in our opinion was not sufficiently brought out, indeed, was not brought out at all, by the defendants, was that very little effect is produced by the variation of a resistance which has a condenser in circuit; it seemed to be implied, by all the plaintiff's experts certainly, that the variation of the rheostat resistance would upset the balance just as it would in the case of an ordinary duplex arrangement where no condensers are in the arms of the bridge. The witnesses even spoke of the "current passing through the condenser;" in fact they, we believe, led Mr. Justice Kennedy to imagine that "the condenser was, with the exception of capacity, equivalent to a *zero* resistance," when actually it was much nearer the equivalent of an *infinite* resistance. In other words, the witnesses would lead one to suppose that if a galvanometer of 5,000 ohms resistance, with a condenser in circuit, had a battery connected to it, and a throw of 100 divisions were produced, then if a resistance of 5,000 were added in the circuit, the deflection would be reduced to 50 divisions, whereas practically no reduction in the deflection would be produced.

Possibly an appeal may be lodged against the judgment, and with a fair chance of reversing the same; but the technical points are so fine, that it will require the greatest skill to do this. As the judgment stands, it seems to indicate that in order to create a new and valid patent we have only to introduce into a combination something which differs slightly from what has been illustrated in describing that combination, and to say that it is an important improvement, whether it works or not, and the desired novelty is effected.

"TELEPHONES: PAST, PRESENT, AND FUTURE."

Mr. Henniker Heaton, M.P., is enlarging the sphere of his activities, and increasing his opportunities for the heckling of Postmasters-General. He contributes to the May number of the *New Review* an article on "Telephones: Past, Present, and Future." In the course of a brief historical introduction, we are told that Reis "only aimed at producing sound of unvarying pitch, . . . and had no thought of transmitting speech." Mr. Henniker Heaton then draws attention to the utility of the telephone, instancing supposed cases of merchants in Belfast and Glasgow transacting business (regardless of the backwardness of those merchants to take advantage of their present facilities); two gouty old friends in Mayfair and Belgravia resuming by telephone their interrupted club gossip, arranging little dinners against their period of convalescence (as if their present sufferings were insufficient to warn them of the evil of "little dinners"); and Edwin telephonically talking to Angelina when ailment or infection prevents a personal call. These are, however, but passing pleasantries to attract attention to more weighty matters. Mr. Heaton has discovered that we are far behind several other progressive nations in respect of our employment of the telephone, chiefly, he thinks, because the Government has been too much occupied with political business to attend to the development of the invention in the national interest. He has "on more than one occasion denounced the timorous and half-hearted policy of the British Government on this question." When the opportunity occurred, it was clearly the duty of the Government to buy up the companies, and to provide the public as speedily as possible with a really cheap and efficient service. In the purchase of the trunk lines "the Government bought the shell and left the oyster to the companies." Mr. Heaton considers the question whether to buy as soon as possible, or to await the expiry of the license in 1911, and decides strongly in favour of immediate purchase. Delay will mean increased cost, and a swallowing up of revenue by interest on outlay. "The consequence will be dear telephony in addition to dear telegraphy and dear cabling."

The difficulties in the way of cheap and effective telephony Mr. Heaton conceives to be two—the Treasury, and the inertness of the high permanent officials of the Post Office. To counteract these evils, "we want some new body strong enough both to resist the Treasury and to stimulate the officials. Such a body is to be found in the Consultative Committee, which I have long called for. This Committee, composed of independent members of Parliament and leading men of business, under the presidency of the Postmaster-General, would consider all questions relating to the service, and record their opinion, which should be laid before Parliament. . . . . If such a committee be—and I trust it will be—appointed this year, one of the first questions laid before it should be this of acquiring the telephones for the nation. Such a question would be promptly and satisfactorily determined."

We are quite in accord with Mr. Heaton in desiring a prompt and a satisfactory determination of the telephone question; but we think it might be better to risk a delayed settlement by inert Postal officials and a rapacious Treasury, than an accelerated settlement through the medium of a Consultative Committee. Of course, it would not be difficult to get together a body of gentlemen who would be fully qualified to advise the Postmaster-General, but it is not everybody who has studied postal questions as fully as Mr. Henniker Heaton. His interest in all matters connected with the Postal Department is so well known, that he might

certainly expect to be included in the "assembly of experienced men of the world, scientists and politicians," who would assist the Postmaster-General, "resist the Treasury, and stimulate the officials." But even Mr. Heaton has not yet mastered the telephone question, in spite of the fact that he "spent a considerable time during a recent holiday trip in examining the excellent telephone systems" in some Australian cities. As a comparison of charges he tells us that "in Adelaide the charge for a private house is only £6 a year, and for an office or business house £10 a year as against £20 in England." Though the rates in the capital of England are double those of the capital of South Australia, the rates in the provincial towns are about the same as those in Adelaide. The size and conditions of London prevent any comparison being made between it and other places. In consequence any such comparisons are misleading.

The comparatively small numbers of telephone subscribers in England is implied by Mr. Heaton to be due to the existence of a monopoly and consequent high charges. Yet, in the course of his article, Mr. Heaton shows that the numbers in America are very much larger, the monopoly more complete, and the charges much higher. In time, no doubt, some other explanation will be sought, but as it is only a matter of telephones, the shallowest argument suffices.

The utility of the telephone is very well recognised by Mr. Heaton even to the verge of extravagance. The advantages so plainly evident now were not so plainly evident 17 years ago. They have been demonstrated as the result of a business speculation. Since the speculation has been successful and proved a great public benefit, Mr. Heaton thinks that "Nothing is more disgusting than the success of speculative monopolists in intercepting and appropriating for their own special advantage every great scientific discovery, which should be freely enjoyed by all." The financier is undoubtedly an important element in the development of scientific discoveries. "Financiers prowl round the inventor's workshop like foxes round a hen-roost," says Mr. Heaton. The remark has some truth. Too often the financier takes care of himself and leaves the inventor to the care of Providence, but happily such an observation is not applicable to telephones. Nor can the financier have a very profitable prowling ground in the neighbourhood of the Post Office, or there would not be so many disappointed inventors unburdening their troubles to Mr. Heaton. "Scores of these unhappy mechanicians have visited me with models and drawings of most useful appliances, all complaining that no definite answer could be extracted from the Department." We fear that in many such cases a definite answer would have only increased the unhappiness of the mechanicians, for to our own personal knowledge there are at least a score impracticable, ill considered, mad-brained projects submitted to the postal authorities to one useful appliance. The unhappy mechanicians are, we might truly say, one and all utterly ignorant of the working of the postal telegraph system of this country, yet they come forward with "improvements" on apparatus of which they have not the faintest conception. The unhappy mortals are the officials who have to spend valuable time in considering and condemning the models and drawings of misdirected inventive minds. There must ever be disappointed inventors; and "consultative committees" be they never so well disposed, will not be able to make the variety extinct.

Mr. Henniker Heaton relies largely on public opinion. Public opinion was violently excited on the question of the telegraphs, and, says Mr. Henniker Heaton, so "it will be, if I have any influence, on the questions of the telephones and the cables." We do not know the measure of Mr. Henniker Heaton's influence, but we do know that there is not at present any public opinion on the question of the telephones. More's the pity! There should be a strong public opinion, but Mr. Heaton is going the wrong way to work in its development. "In my judgment" every private house in England could and should be supplied for £3 a year with telephone exchange communication. We ought to have some evidence of the value of "my judgment," but it is perfectly safe to say that the writer of the *New Review* article has no conception whatever of the problem involved in effecting communication with every private house in England. He simply uses the expression as a rhetorical flourish for the purpose of influencing public opinion. And here we may remark upon the somewhat singular manner in which the public is enlightened on matters telephonic. The last article in the *New Review* on this subject was by the late Duke of Marlborough, who foreshadowed a telephonic millenium through the intervention of the New Telephone Company, but the New Telephone Company has come—and gone—yet the millenium has not arrived. These methods of influencing public opinion are useless, because they are unsound. If Mr. Henniker Heaton wishes public opinion to be brought to bear on the question of the purchase of the telephones by the State, he cannot do better than place before the public well considered arguments based on facts.

It is altogether impossible to over-rate the importance of the telephone question, though some valiant advocates would certainly kill it by exaggeration. It is useless to "play to the gallery" by leading to the expectation of nominal subscriptions. In 1853 a telegram of 100 words from London to Liverpool cost £5. It now costs 4s. 2d., or still less, if for publication. It is unprofitable to speculate upon what telephone subscriptions may be 40 years hence, but it should be clearly understood that the despatch of telegrams and intercommunication between house and house are two distinct problems, involving different conditions and different estimates.

Users of the telephone will have to pay its cost whoever undertakes its supply, and disappointment may result if telephone users are led to expect that wholesale reductions will immediately follow Government purchase. Moreover, railing at monopolies is a mistaken point. The telephone thrives best as a monopoly. That is one of the strongest reasons for the Government undertaking the work. The terms upon which the present system shall be acquired, if acquired at all, may more safely be left to those who have the responsibility to bear, than left to the recommendation of a body of busy-bodies, whether under the name of a consultative committee or otherwise.

Institution of Electrical Engineers.—The annual *conversazione* will take place on May 31st, and as before, will be held in the galleries of the Royal Institute of Painters in Water Colours. Cards of invitation will be issued in the course of a few days.

CHLORIDE OF LEAD BATTERY.

By E. ANDREOLI.

In its issue of March 23rd, page 327, the Electrical Review published a letter which has been the object of considerable attention both in America and in this country. Mr. Gibbs, president of the Electric Storage Battery Company (alias Chloride of Lead Battery, Laurent-Cèly process), who does not seem to be up to date with facts in connection with the E.P.S. accumulators and the French Chloride of Lead Battery Company, parent of his own Company, or who prefers to stretch them a little, has since written a letter in the New York *Electrical Review*, which contains many inaccuracies and misstatements which I will try to set right.

The following extracts from his letter are exquisite specimens of amenities :—

> Mr. Bracken (chairman of the Consolidated Electric Storage Company) states that the Société Anonyme pour le Travail Electrique des Métaux, of Paris, manufacturers of the Chloride battery in France, was sued last year by the company owning the French Faure patent, and that Baron Rothschild, who is largely interested in the Chloride Battery Company, purchased peace at the expense, as he is informed, of several hundred thousand dollars.
>
> This I state to be unqualifiedly false, and it seems remarkable that Mr. Bracken would make a statement, the correctness of which can be determined by the records, without ascertaining as to its truth or falsity.
>
> The facts are that the Société Française, of Paris, controlling the Faure-Sellon Volkmar patents (which are patents covering the ordinary pasted or red lead plate batteries), brought suit against one Pollak, who manufactured a battery having a lead support or base with finely divided elongations in which the active material was pasted and pressed, the variation from the Faure patents being only in the particular method by which the active material was mechanically applied. This case was tried. The District Court, on the testimony of the experts, decided in favour of Pollak. This was appealed, and the higher court reversed the decision. This placed the Société Française in a position where their patents in France practically controlled pasted or red lead accumulators.
>
> As there were a larger number of manufacturers in France, as there are in this country, making these inferior types of battery, through the defects and failure of which the accumulator business has been so greatly discredited and demoralised, the company owning the Chloride battery controlled by the Rothschilds concluded that the purchase of these patents for a nominal consideration would be the best means, during their unexpired term of about two years, of removing from the accumulator field these inferior types of battery, which, notwithstanding 14 years of failure, still continue to claim merit, and made it all the more difficult to convince purchasers that a new principle had been discovered by which a reliable and commercially successful accumulator could be produced. It was for that purpose, and that purpose only, they purchased these patents. No suit was ever instituted under the Faure patents against the society controlling the Chloride accumulator in France.

Need I point out the irrelevant manner in which Mr. Gibbs speaks of *one Pollak*; one is tempted to ask who or what is this Mr. Gibbs. There is as much difference between his statements and the real facts as between his language and good manners.

Far from me to represent the E.P.S. batteries as the most perfect which will ever exist, but there is one thing which pleads in favour of the E.P.S., and which no electrician will deny or forget. If the manufacture of accumulators is now an industry, whatever may be the system adopted, if we have electric light, electric traction, &c., by means of accumulators, we owe it to the energy, initiative and perseverance of that E.P.S. Company which no failure could discourage, in whose works so many pupils learned how to make a secondary battery. Mr. Gibbs, who is not an electrician, does not know this, or he would not speak of an inferior type of battery which has discredited and demoralised the accumulator business.

As chairman of the Chloride of Lead Battery, Mr. Gibbs ought not to speak of credit or discredit or morality. *A bon entendeur salut!*

Whom does Mr. Gibbs believe he is addressing, when he speaks of a new principle having been discovered by which a reliable and commercially successful accumulator (chloride of lead accumulator) can be produced? What is the new principle? It is not, it cannot be, the fusing and casting of chloride of lead: this has been known for years. Is it the combination of fused and cast salt of lead, with a grid, or framework, acting as conductor, to facilitate and accelerate the charge and the discharge?

In that case I will ask Mr. Gibbs, chairman of the Chloride of Lead Storage Battery, who is the inventor of the grid? I am in a better position, and more qualified than anyone else, to say who has discovered this new principle in America, or in this country, or on the Continent.

The services rendered by the E.P.S. are undeniable, but every man who knows the history of secondary batteries will condemn the ignorance of the French judges who found that every company, without exception, who use lead in their plates are infringing the patent rights of the E.P.S. From an historical, as well from a scientific point of view, the E.P.S. batteries are merely an improvement of the secondary batteries in existence before Faure, and certainly no judge will be found in this country, or even in America, who will concur with the French judges and declare that a battery made of fused and cast chloride of lead constitutes an infringement on the E.P.S. rights.

The audacious way in which Mr. Gibbs, chairman of the Chloride of Lead Secondary Battery, goes beside the real facts is something amazing. Whatever he may say with regard to the proceedings against the Chloride Battery Company, it is a fact that the French Chloride of Lead Battery (Société pour le Travail Electrique des Métaux) was only too glad to get out of trouble by paying 1,350,000 francs for: 1. The repayment of the French E.P.S. Company; 2. The payment of their liabilities; 3. Purchase of their works. 1,350,000 francs, *i.e.*, £54,000, does it not make several hundred thousand dollars?

The French Chloride of Lead Battery Company, however rich they may be, would not have paid such a large amount of money for the benefit of the two years more which the E.P.S. patents have to run, had it not been necessary to make a great sacrifice to prevent an injunction which could have put an immediate stop to their existence.

Let us now see what the chloride of lead battery has been in the past, and how it has grown in France, in England, and in America.

(*To be continued.*)

SIR DAVID SALOMONS'S NEW EXPERIMENTS.

The following is a brief description of Sir David Salomons's exhibit at the Royal Society Soirée, last Wednesday. These experiments illustrate certain new phenomena, or phenomena which are believed to be new, in connection with vacuum tubes. The experiments are shown with tubes containing exhausted air, and the current employed is an alternate one. Many of the phenomena require to be shown with very minute currents. In consequence of this method of working, it is probable that many of the effects now observed have been overlooked in the past. These experiments are to be repeated with intermittent direct current and with tubes containing various gases, &c. Although to some extent these have already been carried out, they have not been published up to the present time, the experiments not being completed. The results now to be described are, therefore, limited to the alternate current. The chief phenomena may briefly be summed up as follows :—

1. In a large open tube bands are not formed throughout the length; but when small, this is the case. As the current is increased, the bands appear to be repelled from the centre towards the electrodes until the bands disappear. But, if the current be made exceedingly small, until the tube is dark, on placing the hand on the outside of the tube, thus making it into a condenser, the current will pass through the tube, the tube will light up, and bands will be produced.

2. If a short rod is supported in the centre of the tube and along its axis, these effects can be produced in a more marked manner.

3. Two bright bands are formed on either side of the disc, and these bands are reproduced throughout the length of the free tube the same distance apart as the bands on each side of the disc.

4. A little rod suitably placed at one end of a tube will have bright bands produced at either end, and these bands will be repeated throughout the tube the same distance apart.

5. Contractions, or pierced screens, or any equivalent arrangements, will produce the same effect as the little rod; the regulation being produced by the length of the contraction in one case, and by the distance of the pierced screen from the electrode in the other case, and so on.

6. If the tubes are curved the effects are the same. If a small tube has bulbs blown upon it throughout its length, bands will be formed only in the tube and not in the bulbs.

7. The "sticking" effect of the bands to the glass is shown in a sphere very clearly. A considerable amount of current has to be passed before any of the bands will leave the sides of the glass and take a position parallel to the equator of the sphere; the other bands appearing parabolic in section.

8. Professor Crookes's radiant matter tubes will give the same effects when a very minute current is passed.

9. By altering the amount of current in a suitably arranged tube, it can be shown that, in general, the bright and dark bands are illusory, and that in reality the bright bands become so wide that they overlap; and these overlaps, appearing double as bright as the other portions of the bands, give the impression that these are the bright bands, whereas they are the true positions of the dark bands.

10. If, instead of the electrodes in the above cases inductive arrangements are employed, the same results follow.

PROPOSED UNION OF EUROPEAN INCANDESCENT LAMP MANUFACTURERS.

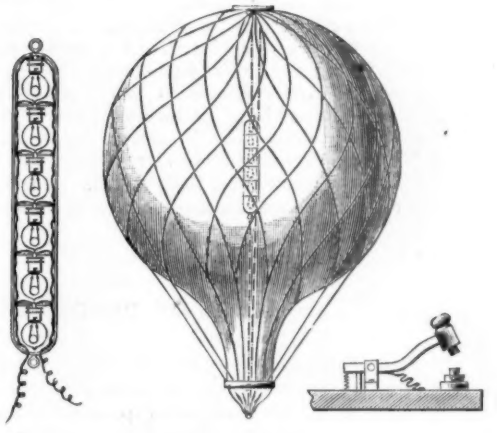
It had been foreseen and foretold that the inevitable consequence of the lapse of the Edison incandescent lamp patents would be the flooding of the markets with cheap lamps. There are only two instances of monopolies secured by patents for electrical contrivances being so scrupulously and successfully enforced, and foreign competition being so strictly excluded from the English market, and these are the telephone and the incandescent lamp. It was but natural that the holders of these two patents should keep up the prices of the two contrivances to the highest possible value, and to some extent they were justified in this course, because they had to fight many a costly battle to maintain the validity of their patents, and, in the case of the incandescent lamps, were only able to pay a fair dividend during the last five or six years.

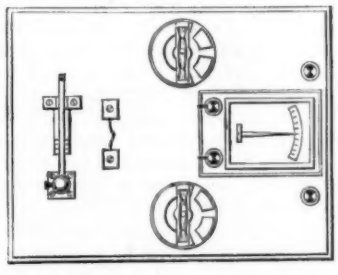
Well founded as these expectations turned out to be, the reality far exceeded all predictions, especially as far as the incandescent lamp was concerned. From all quarters of the globe glow lamps poured into the country, good, bad, and indifferent, the bad ones predominating, of all sizes and shapes, of high and low candle power, of voltage varying from 2 to 150, or more. And, of course, as the lamps were poured in, down went their price; within less than six weeks of the lapse of the Edison patent foreign incandescent lamps were sold in London at 7d. a piece, for which the Edison-Swan Company had charged 3s. 9d. Underselling the market, doing your competitor, became the watchword of the glow lamp trade, and nowhere was this practice carried to greater length than in England. Now, without entering upon the question of the cost of production of an incandescent lamp, it stands to reason that such a state of affairs could only result in the long run in the deterioration of a most important article of consumption, and the utter demoralisation and ruin of the trade, and we hail with the greatest satisfaction an item of news which has just reached us from Germany.

A union is being formed with its seat at Berlin, and to which all the influential glow lamp manufacturers of Germany, Austria, Belgium, and Holland have already given their adhesion, for putting a stop to the disgraceful cutting down of prices in the glow lamp trade. An organising committee of three of the most influential lamp makers has been formed, and a general meeting will be called on June 16th of this year at Berlin. We are authorised to state that there is not the least intention on the part of the union of maintaining the price of glow lamps at anything like the old rate, in fact the price fixed will be found to be below one shilling; the task of the union simply is to secure to the public a reliable article at a moderate cost, and to the manufacturer a fair profit realised by legitimate transactions.

THE BRUCE PATENT ELECTRIC SIGNALLING BALLOON EQUIPMENT.

It has long been the desire of all interested in military signalling, that means might be devised whereby the signalling operation could be carried on in the night time, and at such an altitude as to render the signals visible from a greater distance than is possible with the ordinary lanterns carried by the signalling corps when on foot, and also to prevent the further limitation of this distance by intervening obstructions, such as trees, buildings, or rising ground. Various methods have, from time to time, been proposed to overcome these difficulties and attain the object in view, among these being a suggestion that the clouds might be utilised to reflect flashes of light, and by means of any pre-arranged code of long and short flashes, transmit the message desired. Two obvious disadvantages of this plan are that it can only be used when clouds are present in the atmosphere, and should a cloud pass away before the completion of a message, it would probably not be understood by the receiving party, or might even have its sense entirely altered. The signalling has sometimes been accomplished by lanterns operated in the car of an ordinary balloon, but this method necessarily requires a balloon of large gas capacity in order to overcome the weight of the car and gear connected therewith, and entails great difficulty in transport, especially in mountainous





or broken country, owing to the large amount of waggon space taken up by the balloon and appurtenances, and the number of cylinders required to carry the compressed gas for charging purposes. Some time since, Mr. Eric Stuart Bruce, M.A., Oxon, turned his attention to this subject, and succeeded in producing an apparatus which has met with a large amount of success, and has been adopted by the British and some foreign governments. This method consists in suspending a number of incandescent electric lamps inside a captive balloon of comparatively small size, having a semi-transparent envelope, the current being supplied from any available source on the ground, and a key, somewhat similar to the Morse key used for telegraphic purposes, is placed in the circuit, so that make and break can take place quickly and easily. In his earlier efforts in this direction, a key was used having sliding brass contacts faced with platinum; but it was found that with this form of key the signalling could not be carried on with as great facility as was desired. Some difficulty was also experienced in procuring lamps with carbons sufficiently fine to prevent the

after-glow interfering with the distinctness of the several flashes. Considerable improvement in the whole apparatus has since been made, and we show in the accompanying illustration the latest development of the idea. This balloon and equipment has recently been supplied by the inventor to Messrs. Siemens Brothers for the Italian Government. The balloon is made of cambric, this forming an envelope which is perfectly translucent. It has a diameter of 18 feet, and a gas capacity of about 3,200 cubic feet. The lampholder is made in the shape of a ladder, so as to admit of its easy introduction into the narrow mouth of the balloon, and contains six incandescent lamps. These signalling lamps are of 16 candle-power, 55 volts, and are specially constructed for the purpose, the carbons being finer and the bulbs more spherical in form than is usual. After the balloon is inflated this lampholder is drawn up into its centre by a cord passing through a small pulley block secured to the valve seating on the top of the balloon, and the current is supplied through insulated cables from secondary batteries, or if these are found to be too heavy for transport, or are not available, a small dynamo is used, which, in the event of no other power being at hand, may be driven by manual labour. The keyboard, which is under the control of an operator on the ground, is fitted with the newest form of the Bruce signalling key, the contact pieces being short thick carbon rods fastened into brass sockets by set screws so as to be removable, being thus easily and cheaply renewed when worn away by sparking. It also contains an ammeter, a switch to turn on the current to the lamps, either through the key for flashing signals, or directly for continuous illumination, a switch to throw the ammeter into the circuit, and a safety cut-out. The equipment includes net, valve top, hose for filling, sand bags, and a special ventilated case for sea transport, a car being entirely dispensed with. As an instance of the distance at which signalling may be carried on with this apparatus, Mr. Bruce states that when a trial was made from the grounds of the Albert Palace, Battersea, the signals were discernable at Uxbridge, a distance of upwards of 16 miles.

THE QUEEN-LE CHATELIER PYROMETER.*

Modern investigation and many of our modern industries demand an instrument for the accurate measurement of very high temperatures. A vast amount of experimental work in this line has been done by physicists and metallurgists in the past, their most noteworthy results having been achieved by the employment of the air or gas thermometer, which depends for its action upon the expansion of air instead of mercury, as in the ordinary forms of thermometers. The bulbs of these thermometers they constructed of materials like glass or platinum, whose melting points are very high. In the more recent experiments, however, porcelain bulbs were used. These air thermometers are not convenient or practical instruments, requiring, as they do, a great deal of subsidiary apparatus and the application of many corrections to the readings. With them, however, eminent scientists have done us invaluable service by establishing many fixed temperatures, such as the melting points of various metals. These may safely be relied upon in graduating other forms of pyrometers.

M. Le Chatelier, in constructing his pyrometer, has made use of these known melting points. It is based upon the principle of measuring the electric current generated by the heating of a thermo-electric junction. As modified by Queen & Co., it consists of a thermo-electric couple and a d'Arsonval galvanometer. The wires which compose the couple are one of pure platinum, and the other platinum alloyed with 10 per cent. rhodium, both of which are perfectly homogeneous. For use, the couple, which has been first connected with the galvanometer, is inserted into a furnace or oven, when immediately a current is produced and measured on the galvanometer scale, from which the temperature is readily deduced.

The following advantages are claimed for this pyrometer: First—It is adapted for a very large range of temperature, *i.e.*, from 200° to 3,000° Fahr., but is intended more specially for high temperatures, such as are met with in the manufacture of metals, chemicals, porcelain ware, &c. Second—It is almost instantaneous in its indications, five seconds being sufficient time to subject the couple to any stationary temperature; or the couple may, if desired, be left permanently in the furnace or oven, indicating at all times the temperature, and thus enabling the operator to keep an hourly record of same. Third—The metals which compose the couple are not affected by gases, and hence will not become oxidised or react chemically on each other at high temperatures; nor are they altered in their thermo-electric properties by rough usage or bonds.

From the above statements it will be readily seen that the instrument is of great accuracy and durability. The measurement of the temperature is made by means of a d'Arsonval galvanometer, contained in two wooden boxes, which are screwed against a central wall or slab with handle, for portability. Fig. 1 shows the two boxes unscrewed from

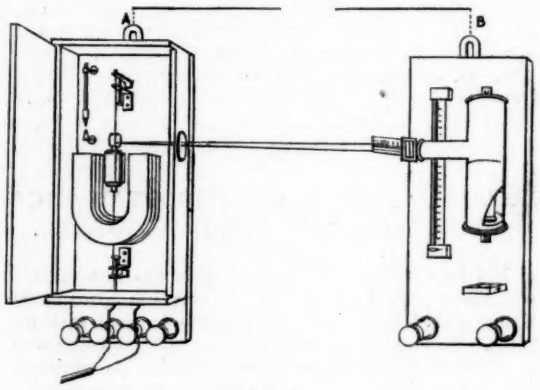


Fig. 1.

the central slab and placed in their respective positions against the wall. Box A contains the galvanometer proper, and is also provided with set screws and a small plumb bob, so that it may be set vertically. Box B contains the lamp, having a lens and window with cross-hairs for throwing an image upon the galvanometer mirror in box A, which in turn reflects it back upon the scale in box B. Box B has also two set screws for adjusting it vertically. The two boxes are set one metre apart.

The current set up by the thermo-electric couple (no battery is used) enters the galvanometer through the two binding posts, box A, and the deflection caused by it is shown upon the scale, box B. This scale is graduated in millimetres, and it is necessary, therefore, that a curve be made reducing these millimetres to degrees Fahrenheit or Centigrade. This curve is very simply made from known melting points given herewith: Water boils, 212° Fahr.; lead melts, 617° Fahr.; zinc melts, 779° Fahr.; gold melts, 1,913° Fahr.; palladium melts, 2,732° Fahr.

ON THE EFFECT OF HEAVY GASES IN INCANDESCENT LAMPS.

Our American contemporaries have lately been publishing accounts of a lecture delivered by Prof. Wm. A. Anthony on this subject before the American Institute of Electrical Engineers. It will be remembered that this *savant* was one of the witnesses for the defendants in the late Novak lamp case, a report of which appeared in our issue for January 12th. The leading feature of that case was the claim that the Novak lamp was not an infringement of the Edison lamp as bromine vapour, in appreciable quantity, was used in the lamp bulb instead of a vacuum as complete as possible, as specified by Edison. The Professor has evidently given much thought and attention to the subject and now ventilates his views in a clear and interesting manner.

The lecturer commenced by referring to the now well

* New York *Electrical World*.

recognised law, consequent mainly on the blackening of lamp bulbs, that it is economical to renew lamps every 300 to 500 hours. The value of a long lived filament in a blackened lamp is nil, and it was justly argued that a lamp which will last the above time at a *good efficiency* throughout its life would be an improvement on the present vacuum lamps. This desideratum is just what the bromine lamps, devised by John Waring, are claimed to have accomplished. The blackening is said to be inappreciable, and the resistance of the filament not to increase, the result being that the candle-power is maintained throughout the life of the filament. Some interesting life and candle-power tests were described, in which lamps of identical manufacture were made respectively into bromine and vacuum lamps, the advantage in every case coming out in favour of the bromine lamps. Table I. indicates the result of an abnormal test made by the Professor himself. The conditions were that some 50-volt 16 C.P. lamps of both descriptions were run for 3½ hours at 65 volts, and for 1½ hours more at 70 volts, that is 20 volts more than the normal voltage. Table II. shows another test made at the Waring factory under normal conditions of running.

TABLE I.

	Lamps, new.			After 5 hours at 65 and 70 volts.		
	Volts.	C.P.	Current.	C.P.	Current.	
1	49	16	26	9·4	24	Vacuum lamps.
2	49·6	16	26	10·3	24·6	
3	49	16	26	10·6	24·8	
4	49·2	16	26	9·8	24·8	
5	49·8	16	27	Broken	...	Bromine lamps.
6	48·8	16	26·5	15·5	26·2	
7	49	16	27	15·1	27·2	
8	50	16	26·5	Broken	...	

Note.—Vacuum lamp blackened. Bromine lamps not blackened.

TABLE II.

LIFE TEST OF EIGHT VACUUM AND EIGHT BROMINE LAMPS.

	Mean of 8 lamps at 0 hours.			Mean of 8 lamps at 210 hours.			Mean of 7 lamps remaining at 400 hours.			Mean of 6 lamps remaining at 625 hours.*		
	Volts.	Amp.	C.P.	Volts.	Amp.	C.P.	Volts.	Amp.	C.P.	Volts.	Amp.	C.P.
Vacuum	51·35	1·6888	25	51·35	1·739	22·31	51·26	1·704	20·17	51·38	1·698	18·18
	8 Lamps.			7 Lamps remaining.			5 Lamps remaining.			3 Lamps remaining.		
Bromine	54·16	1·768	28	54·36	1·816	28·26	54·92	1·792	29·24	55·37	1·857	29

* One of the six vacuum lamps has a very bright spot on the filament, and can only last a few hours longer.

In the latter experiment there was no decrease in efficiency in the bromine lamps after 400 hours, and in 600 it was scarcely 3 per cent. In the vacuum lamps, however, the efficiency fell 20 per cent. in 400 hours, and 27 per cent. in 600 hours. The breakage of filaments in the bromine lamps is much heavier than in the vacuum lamps, but although only one of the latter had actually broken they were all economically dead at 400 hours.

The Professor then dwelt at considerable length on the conditions existing in the lamp bulb during incandescence. The blackening material obviously emanates from the filament and must therefore be carbon. The mode of its transference has been attributed to three possible causes: First, to "air washing" or attrition, whereby the heated carbon is supposed to combine with the residual oxygen remaining in the bulb, the carbonic acid or carbonic oxide becoming dissociated with deposition of carbon on the glass; second, to the carbon being thrown off in particles by electrical force in what is called the Crookes tube effect; and thirdly, to the direct formation of carbon vapour in consequence of the high temperature. The first of these was held to be untenable in view of the results obtained with lamps containing bromine and other gases. This decrease in blackening effect due to the presence of gases was no new discovery. Edison had made it the subject of a patent in 1883, and in the same year in Europe Proctor had published in *Nature* that it had been noted that the blackening was greater in lamps with high vacua than in those less perfect. It has further been claimed that lamps exhausted by mechanical pumps blacken less than those exhausted by mercurial pumps, and the Professor considered the reason of this to be because they were less perfectly exhausted, and was not due in any way to the presence of mercury vapour.* In a highly attenuated vacuum the formation of carbon vapour is facilitated, and there can be little doubt that the deposit occurs from the slow emission of carbon vapour, combined, perhaps, with an electric emissive action. In the Crookes tube effect the motion of the particles is due to considerable electric potential, whereas, in the incandescent lamp the potential is very low in comparison. In the former case the particles moved in straight lines, but that was simply due to Newton's first law, which says, "Every body continues in a state of rest or motion in a straight line, except in so far as it may be compelled by force to change its state," and the straight line taken in the Crookes tube was owing to the comparative freedom of the path from obstruction, and to the great difference of potential which was needed to overcome the obstruction. Prof. Anthony next endeavoured to show that while certain materials and under certain conditions were transmitted in straight lines, that carbon in an incandescent lamp does not do so, but that it is deposited on the glass perfectly uniformly. We quote the following extract from the *Western Electrician*:—

> In the old Edison lamps the filament was copper-plated to the platinum wires. When a break in the filament occurred near the junction, the arc evaporised the copper and covered the bulb with a coating of metallic copper, except that a line of clean glass was often left on the side opposite the break, the line being the shadow of the unbroken leg of the filament. This is described by Dr. J. A. Fleming, who says that he has never seen this shadow except in the copper deposit, that it is never seen in the deposit of carbon. To quote his words: "Hence there must be some essential difference between the vaporisation of the carbon and that of the copper. The carbon deposit resembles more the condensation of a vapour and is uniformly distributed, but the copper deposit exhibits the character of a molecular radiation or shower taking place from a certain point." He adds: "The whole phenomenon calls at once to mind the beautiful researches of Mr. Crookes with vacuum tubes. Here, however, we are dealing not with an induction coil discharge, but with a comparatively low potential." Let us analyse the phenomenon. The filament breaks at the copper junction, and an electric arc is formed, in which copper is vaporised with comparative ease. A large volume of copper vapour is formed almost instantaneously in a space almost devoid of other matter. The sudden expansion of that vapour is sufficient cause for the projection of the molecules in straight lines to the walls of the chamber. It is not necessary to assume any refined electrical forces to account for the rectilinear path. The plain old-fashioned, unpretentious vapour "tension" that bursts our steam boilers is all-sufficient to account for this rectilinear projection across the lamp bulb, when there is nothing in the way.
>
> I might quote many references to show that the carbon deposit never shows a shadow, and Mr. Proctor, in the note already cited, states that a platinum deposit formed under precisely the same conditions as the copper deposit described above, never shows the shadow.

With all due deference, however, to Prof. Anthony and the other authorities quoted, we emphatically maintain that

* The writer of the present article has heard, on good authority, that the lamps of one well-known American lamp maker who uses mechanical pumps, blacken quite as much as other lamps on the market.

the carbon molecules or particles *do* travel in straight lines, and that shadows and accumulations of the carbon deposit *do* occur in certain incandescent lamps where the conditions for their production are favourable. The shadow of the filament—a very fine one of course—is sharply defined the glass of every well blackened lamp containing a symmetrically shaped ∩ filament, and it may be readily perceived by carefully examining the lamp bulb in a good light. It is obvious that at every part of the bulb light shines from both limbs of the filament, excepting at the narrow part where the further limb is hidden by the nearer one. The blackening at that part is therefore only one-half the depth of the rest of the globe, as it only receives a shower of particles from one limb instead of two. If the carbon particles met with obstruction in their path towards the glass and were thus made to deviate from the straight line, no such sharply defined line would be visible.

Some interesting matter relative to the evaporation of metals in vacuo and under electrical influence was also given; the point of all the above being to demonstrate that these effects were only produced under considerable electrical pressure, and that electrical projection does not play a material part in lamp blackening. All incandescent lamps of every voltage blacken equally, whereas if electrical projection were the cause, those of high E.M.F. should blacken more than those of low potential.

The well-known conditions for the production of ordinary vapour of a substance were then discussed. Every substance at a given temperature has a specific vapour tension, the rate at which the vapour is formed, at a given temperature, being decreased by the presence of a sorrounding gas. It was further asserted that by using a gas of high molecular weight in the lamp chamber the volatilisation was less than with a light gas. A heavy viscous gas checked better the circulation of the carbon vapour which existed immediately around the filament, and if the circulation could be still further impeded, the life of the carbon would be still further increased. The reason why the bromine lamps did not last quite as well as the vacuum lamps was, probably, because the filaments in the latter became duller and duller with age, owing to increase in resistance, whilst the former kept a uniform brightness, and therefore ran at a disadvantage compared with vacuum lamps.

CORRESPONDENCE.

Varley Testimonial.

I would ask to be allowed, through the medium of your columns, to express my deep obligation to the members of the Testimonial Committee for having so gracefully recognised my services to applied science in the circular they issued shortly after the formation of the committee. I would also ask to be permitted to return my sincere thanks to all those who have subscribed to the testimonial fund.

My thanks are, I feel, in a special sense due to Lord Kelvin for so kindly accepting the post of chairman, and for taking an active part as leading member of the committee. I wish also to express my deep obligation to the three executive members on whom the work has chiefly fallen, viz., Mr. Crompton, the hon. sec., Mr. Gatehouse, and Mr. Stroh, the treasurer.

And now that the testimonial fund has been brought to a close, I find it difficult to realise that nearly nine years have elapsed since I was first looked up on behalf of leading firms who refused to recognise the claims asserted by the Anglo-Brush Corporation.

At that date, for reasons which came out in evidence in the Law Courts, I was reluctant to take the initiative in asserting my claims as the inventor of compound-winding, but when my anticipation of the Brush patent had been brought forward publicly in the interests of the dynamo industry, I considered that I owed it as a duty to myself, as well as to the trade, to establish the priority of my invention, and from that time I regarded the matter as a duel between Brush and myself, and a battle with the scientific experts who were assisting the Anglo-Brush Corporation.

In the beginning of December, 1887, to my very great regret the firms in whose interests I had been originally looked up retired from the defence, and a compromise altogether in the favour of the Brush Corporation was arranged.

An article recently published in the *Pall Mall Gazette*, headed "At a Vigintave," throws a side light on how it came about that wealthy English firms should have given way without fighting a battle. In the article I am referring to, Colonel Gouraud is reported to have said, "I am a firm believer in litigation as the only test of a patent's merit. Look at the telephone now! The very first thing I did when I got a wire from Edison to say that he had invented a telephone and wanted me to take it up, before I had even seen the instrument, was to go off and retain the three best patent counsel in the kingdom. The result is that we have never lost a case." Now the Anglo-Brush Corporation acted on similar tactics to those of Colonel Gouraud; they retained Sir Richard Webster, Mr Moulton, and other of our ablest counsel, as their legal advisers, and as scientific experts they retained Sir William Thomson (Lord Kelvin), Sir Frederick Bramwell, Messrs. Latimer Clark and W. H. Preece, Profs. Perry, Silvanus Thompson, &c., &c.

It is a matter of history that all the more important electrical cases previous to that of Brush *v.* Crompton, with the single exception of Wilde *v.* Gramme, had been mainly won by the ability of counsel, the official status, and the clever special pleading of scientific experts, and that being so, the defendants in the case of Brush *v.* Crompton, although they had no manner of doubt as to the soundness of the defence, considered themselves to have been strategically outmanœuvred, and under the circumstances they came reluctantly to the conclusion that discretion was the better part of valour.

So soon as I was advised that a compromise had been arranged, I determined to try and get the case re-opened, and in a series of articles published in the ELECTRICAL REVIEW I discussed the respective claims of Varley and Brush to be considered the first to have described a system of compound-winding.

In the course of my articles I expressed the opinion that the trade had allowed the Anglo-Brush Corporation to simply walk over the course, and that it seemed to me they had acted very short-sightedly in doing so. I stated it required no prescience to foresee that the next step on the part of the Brush Corporation would be to apply for a prolongation of their patent, and, I added, who shall blame them, seeing that, under the circumstances, they would probably be successful. I also directed attention to the fact that the previous attempt of the proprietors of the Wilde patents to obtain a monopoly of the dynamo industry had been successfully resisted,* and referring to what I would now term "Gouraud tactics," I said a feeling had been growing upon me for some time that there was need for a new strategy, that it was seldom sufficient to act solely upon the defensive, decisive victories being obtained, more often than not, by flank marches and attacking the base of operations. I then proceeded to analyse the affidavits sworn to on behalf of the Anglo-Brush Corporation, and after showing how weak they really were, I said if the trade would rally round me, I would make it a life and death struggle, and take the matter up with the determination to win.

The outcome of my articles was that Messrs. King, Brown and Co., of Edinburgh, decided to oppose the Anglo-Brush Corporation, and I was given a verbal assurance that they would carry the case through the Scotch Courts, and assuming they were successful, if the case were taken to the House of Lords, they would fight it there.

Instead of waiting to be attacked. Messrs. King, Brown and Co. assumed the offensive, and as English counsel cannot plead in Scotland, this strategy checkmated the "Gouraud

* In the law suit of Wilde *v.* Gramme, the proprietors of the Gramme patents, who were foreigners, finding themselves involved in very considerable expenditure, resolved to withdraw from the defence. I regarded their doing so as little short of a catastrophe, as I foresaw it would probably result in the formation of a wealthy syndicate, and the making the dynamo industry a close monopoly. Under these circumstances I offered my professional services on the side of the defence gratuitously, and I had the unique advantage of being the sole scientific adviser. Wilde was successfully resisted, the battle being practically won at the disclaiming stage, as leave to disclaim was refused, and when the case was called in Court, it was allowed to go by default, Wilde paying costs.

tactics," for it broke up that organisation of able barristers and scientific experts, who had won electrical case after electrical case in the English Courts, and as a consequence, the battle was fought out on less unequal terms than it otherwise would have been.

When the time for hearing the case for the reduction of the Brush patent was drawing near, the Anglo-Brush Corporation tried to arrange a compromise, and they offered terms favourable enough for the legal advisers of Messrs. King, Brown & Co., to advise their clients to accept. I energetically opposed any compromise being come to, and the raising a guarantee fund was offered me as the alternative. I at once issued a pamphlet to the trade and brought my personal influence to bear also; a guarantee fund was raised, and the respective claims of Varley and Brush to be considered the inventors of "compound-winding," were fought out in the Court of Session, Edinburgh, in November, 1888. Some months later judgment was given altogether in favour of Varley, and on appeal this judgment was not only sustained but strengthened.

The immediate effect of the second judgment delivered in the Scotch Courts was, that the Anglo-Brush Corporation found it necessary to liquidate, and to reconstitute themselves as a new company. The case was, however, carried to the House of Lords, and, as is well known, the Lords delivered judgment on April 4th, 1892, and without hearing counsel on behalf of King, Brown & Co., they declared Varley to be the inventor of "compound-winding."

The part I have been permitted to play in respect to the dynamo it must be admitted is unique. The discovery of what Lord Kelvin has aptly named the dynamo principle is admittedly one of the greatest discoveries of the century. I was the first to discover this principle, and the original dynamo constructed in August, 1866, and provisionally protected in December of the same year—the first machine made of the type of dynamos now in use—and for the designing of which, I was awarded the gold medal of the Inventions Exhibition of 1885, is at the Patent Museum, South Kensington. I am also the inventor of the second great advance in dynamo construction, viz., compound-winding. My claims to this invention have been thoroughly sifted by the highest Courts in Scotland and the United Kingdom, and although opposed by a most powerful financial corporation, assisted by the highest legal and the highest scientific talent, whatever claims I have urged as the first inventor, have been fully sustained in each of the three judgments delivered.

I have the satisfaction of feeling that in the course of my life it has fallen to me to make advances both telegraphically and electro-dynamically; I have the satisfaction of feeling, also, that I have been the means of rescuing the industry from being made in no small degree a monopoly.

I might be forgiven, I think, were I to take credit for having invented a legal strategy which enabled me to successfully deal with an organisation having its origin in the Government telegraph monopoly, but which had been developed by powerful financial corporations into what seemed to be an all-powerful machine for crushing out private enterprise; but if I take credit to myself for pioneering a new strategy, I do not overlook the fact that it would have been of no avail but for the public spirit of a Scotch firm, who took upon themselves the responsibility, and incurred considerable expenditure, in fighting what was really the trade's battle quite as much as their own.

The pecuniary gain to the industry which has resulted from reopening the case after the trade had given way must have been very great. To myself, the period now being brought to a close has been one of labour and great mental anxiety, for I have felt all along the heavy responsibility I undertook when I urged the trade in 1887 to rally round and resist. I took up the case as I promised, with the determination to win, and, in carrying it through to success, I have given my time, in no small degree, gratuitously.

A list of the names of those who have subscribed has been given me, and I am very pleased to find among the subscribers the names of men of the highest distinction in physics, in electrical engineering, and electric pioneering, and the legal profession; but, at the same time, I confess it is depressing to me to find that, with the exception of a few of the more distinguished members of the dynamo industry, the manufacturers who, as a whole, must have largely benefited from my successful efforts to overthrow monopoly, should not have responded to the invitation of the committee.

I feel very much indebted to the committee, and therefore I hope I shall not be misunderstood when I say I am sorry it has been found necessary to protract their proceedings over so long a period; memories are short in these days of high pressure, and when any one has arrived at the wrong side of 60, two years is a considerable portion of his life.

I am pleased to be informed that Lord Kelvin is exerting his exceptionally powerful personal influence to carry successfully through a resolution passed at one of the meetings of the committee. It is very important to me that his efforts should be crowned with success. The matter, I am sure, could not be in better hands, and I shall always feel that Lord Kelvin has placed me under a special obligation.

S. Alfred Varley.

April 28th, 1894.

Manganin.

In reply to Messrs. Glover's letter, I may state that the sample of manganin was not supplied by their firm. I may also add that the test could not have been masked by the presence of pieces of steel off the file, because the piece of manganin tested was *entirely* reduced to powder, and the whole of this proved to be magnetic.

David Salomons.

The Livet Destructor.

As there appears to be an impression abroad that the letters M.A.S.C.E. appended to the name of one of the engineers of the Livet destructor, signify that the possessor thereof is a Member of the American Society of Civil Engineers, I should like to say, in fairness to the Society, that the name in question does not appear in the Register. The mystic letters must therefore signify something more occult—possibly Master of Arts, Scientifically Aided. Had they signified membership, as supposed, it would have been the duty of the holders to have obeyed the rules of the Society and used the form I now append hereto, namely,

M.Am.Soc.C.E.

April 30th, 1894.

Muirhead v. Commercial Cable Company.

To those of us who have had a certain amount of experience in duplexing both long and short cables by means altogether independent of the apparatus made by Messrs. A. & J. Muirhead, it has been a matter of surprise to read certain portions of your version of the evidence given in the recent case of Muirhead *v.* the Commercial Cable Company. On reading the evidence given by experts on both sides, we are supplied with much food for reflection, and we are shown what remarkable errors even men of renown may fall into.

When an almost absurd mistake is noticed, given in evidence with all the seriousness suitable to such an occasion, one cannot help discounting to a very great extent the value of the evidence altogether. The most striking point of incorrectness which I think will be clearly understood by electricians who have had experience in duplex working, is the statement made by Lord Kelvin and endorsed by Prof. Bottomley, that where condensers are used in both arms of the bridge, the sum of the resistances used in combination in the arms of the bridge *must remain constant.*

Taking fig. 3 in the 1880 patent, the total resistance of the rheostat, x, need not be more than 20 ohms, divided into sub-divisions varying from ·01 to 10 ohms in value. This rheostat, I may remind you, is divided by the earth contact through the key, into two parts. I ask what practical effect can the abolition of this resistance have on the signals on a circuit of above 7,000 ohms, which I believe is the approximate resistance of the Waterville-Canso cable of the Commercial Cable Company, so long as the balance remains good? The shunting or retarding effect referred to by Lord Kelvin is, of course, practically *nil.*

This graduated resistance is employed to split up the

sending current into the correct proportions to neutralise any discrepancy between the actual and the artificial circuits, so that the sending current passes both poles of the receiving instrument at an equal potential when the other end is not sending. When this result is obtained, duplex working is installed, and so long as the ratio is maintained, the sum of $r_1 + r_2$ could be altered every time of adjustment, varying from 1 to 100, or even 200 ohms, without having any practical effect on a circuit such as this case involves. Perhaps Lord Kelvin and Prof. Bottomley meant that the respective resistances in the arms of the bridge should remain constant. This is equivalent to saying the cable should not be broken, or the artificial line damaged, as the maintenance of a balance obviously depends upon the constancy of the electrical condition of actual cable, artificial cable, and every piece of apparatus and connections used.

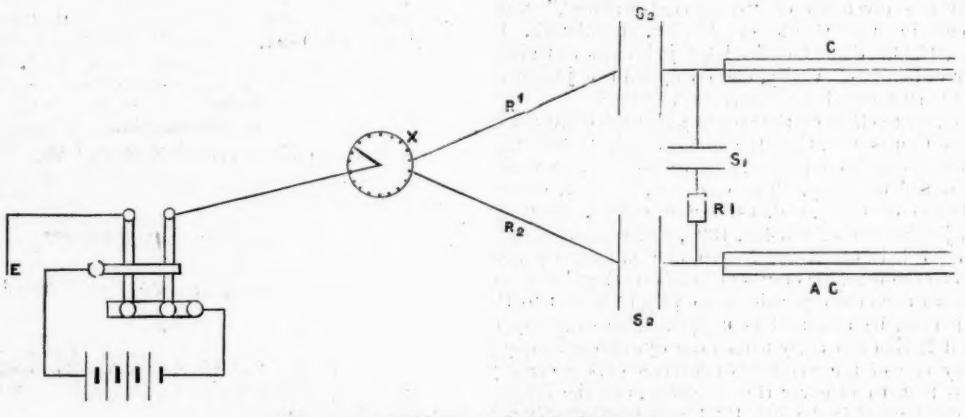
If an adjustable resistance is used at all at the vertex of the bridge, it is not essential to use the form as shown in Muirhead's 1880 patent, one can be used similar to that as shown in sketch, where the resistance is inserted or taken out of each arm by means of plugs, and the sum of the resistances in the two arms could be altered at will within the prescribed limits of the box. Although this box may not be so readily adjustable, it does away with the great danger of an indifferent contact which so often occurs where a slide contact is used, the points of contact in a slide being liable to oxidise and get dirty. There is every reason, therefore, to adopt this form of resistance at the vertex of the bridge, as shown in sketch, to divide the sending current as one likely to be more constant. It must be borne in mind that a very small variation in the respective resistances of r_1 and r_2 materially affects the respective quantities into which the sending current is split, as it deals with it at its greatest strength. It is a question whether constancy is not of more value than ready adjustment. It seems to me the former is undoubtedly the aim to strive for, and to do this a rheostat at the vertex of the bridge, such as Muirhead employs, should not be used.

There are a multiplicity of additional methods of adjusting a balance, several of which are quite as important as the resistance at the fork of the bridge. I may mention one or two, viz.: A finely sub-divided condenser in either or both arms of the bridge, as an auxiliary to S_1 and S_2, and it is very often expedient to insert variable leaks at different points along the artificial cable.

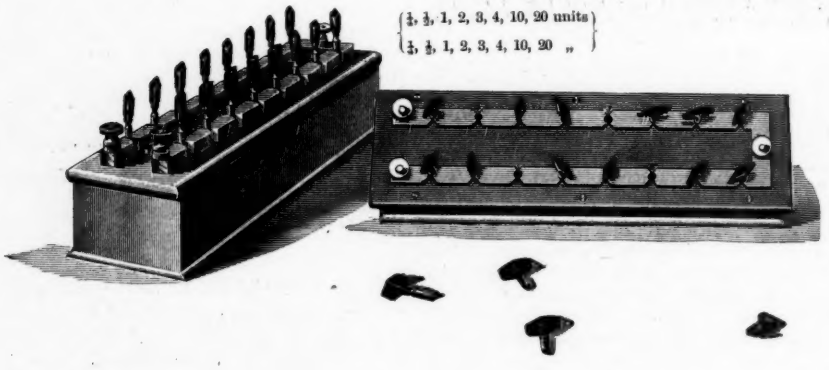
It is much to be regretted that those who accepted the responsibility to give evidence in this duplexing case, should have apparently made statements that even a junior clerk in a telegraph station would doubt the truth of.

It seems necessary to remind these gentlemen that great value is attached to their opinions given under these circumstances, and they have considerable influence in creating or continuing an injustice.

Geo. Herbert Bailey.



C, Cable; A C, Artificial Cable; R 1, Receiving Instrument.



Country House Lighting.

In reply to Mr. Arthur Bergtheil's letter in your last issue, I regret that my mention of Messrs. Carwardine's electric lighting and power installation should read as if I thought that the windmill motive power had been discontinued through any fault of the windmill. I am well aware that it was due to the action taken by the London County Council against the windmill as a "sky sign" that led to the stoppage of what would have been a very interesting experiment, and in my MS. I had referred to the litigation on the subject, which was afterwards cut out as it seemed to me to be so well known.

I beg to thank Mr. Bergtheil for his offer of newspaper reports, but I have them all, including a full account in the *Engineering Review*.

As regards storage, my information was collected on the spot, and in all probability my informant misunderstood my question as to the number of lamps originally installed. As only two 8-ampère arcs were put in at first, the cells, if fully charged and new, would have supplied current for about 13½ hours, not very much for winter work, but, of course, sufficient for ordinary working.

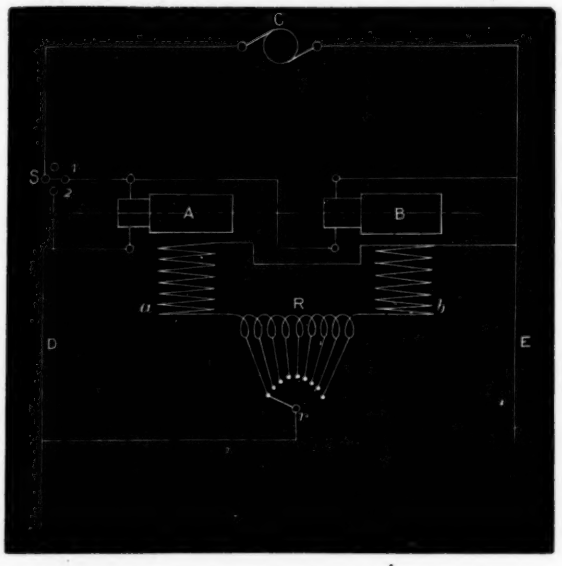
I will see that these corrections are made in printing the *Proceedings* of the C.M.E. Society, and am much obliged to your correspondent for the information.

Sidney à Court.

Mr. Ward Leonard's System for Regulating Motors.

Referring to Mr. H. Ward Leonard's proposal for the use of motor-generators in the starting of electric motors, and your comments thereon, I beg to hand you a sketch showing an alternative mode of connection and working, which appears to me to possess some advantages over that described in your current issue.

In the sketch, A B is the motor-generator, with field-magnets, *a* and *b* respectively, and C the driving motor; S is the main switch, and R a resistance which by means of the switch, *r*, can be variously divided between the two parallel shunt circuits through *a* and *b*; D and E are the leads.



When switch, S, is open, motor, C, is cut out, and the armatures, A and B, are in series and running light. For starting C, switch *r* is put into the position shown, so that *a* is fully excited and *b* most feebly; and switch S is placed on contact 1. Current now passes from the positive lead, D, through A, driving it as a motor, and losing pressure (say 460 volts out of 500), and continues through C to E. At the same time B is driven as a generator by A, and supplies a large current at low pressure to C.

As the speed of C increases and a higher pressure is needed, *r* is turned over so that the excitation of *a* is lessened and that of *b* increased, with corresponding variations of pressure at A and B. The speed of C can thus be regulated by the movement of *r*.

When long runs without stops are anticipated, switch S can be changed over to contact 2; C being then driven solely by the main current, and A and B running light.

With this arrangement of apparatus the armatures, A and B, act in parallel when supplying current to C, and, consequently, need not be so large as in Mr. Leonard's arrangement, where A has to supply power to drive B, and B has to supply the whole current for C.

W. S. Boult.

The Heilmann Locomotive: Mr. H. Ward Leonard's System for Regulating Motors.

In your issue of April 20th, Mr. A. G. Seaman suggests that I may be able to help in the problem of constructing a generator to run without sparking with $\frac{1}{10}$th its normal field, speed and current being normal. My reply is that this can be and is done quite readily under my patents; the reason being that with my winding the armature current itself supplies the reversing field. The compensating machines supplied to the Midland Railway Company for their Derby station have been running almost constantly since they were put down, with excitation varying from *nil* upwards, without sparking or trouble of any kind.

With reference to your article "On the Heilmann Locomotive from an Electrical Point of View," I may point out that there would be no such losses as you speak of in the process of starting up if both generator and motor were series wound and permanently connected up. The loco. would be stopped and started by the engine, the maximum torque would be applied at all speeds, and there would be little or no trouble with the commutators, even if the ordinary type of machine were used. I do not remember that you have stated what the actual arrangement and procedure is, but I may be mistaken, as I have not re-read the articles which have appeared in your paper on the subject.

W. B. Sayers.

Self-Lubricating Bearings.

Referring to your "Business Note" in the last issue of the Review, I note your remarks on self-lubricating bearings, and quite agree with your good opinion of them. We have here, in our mill (Messrs. B. Vickerman & Sons, Limited), a bearing in which the oil has not been renewed for seven years, and it appears as good as ever, and has run regularly 60 hours per week during this period. I hope Mr. Farrar has not spent any money to protect or patent it, as it has been public property rather over nine years.

R. A. Goodman.

GLASGOW ELECTRICITY SUPPLY.

Mr. Wm. Arnot, A.M.Inst. C.E., recently read a paper on "The Corporation Electric Light Supply," before the Scottish Institution of Engineers and Shipbuilders on March 20th. The following is an abstract of the paper and discussion:

The provisional order obtained August 14th, 1890, gave the Corporation two years to carry into effect the powers granted therein.

Lord Kelvin was consulted October 9th, 1891, and his advice was most decided on the advisability of supplying with a direct current at not more than 200 volts.

It having been decided to adopt a low tension three-wire system, Prof. A. B. W. Kennedy, F.R.S., was requested on November 12th, 1891, to prepare a scheme.

A site was obtained in Waterloo Street, at the corner of Mains Street, and the contract for the building was signed on April 7th, 1892. On Saturday, February 25th, 1893, the arc lamps on the principal streets were first lighted, and the current was switched on to the incandescent mains on Saturday, April 22nd, 1893.

My paper on this subject would be incomplete without reference to the work carried out by Messrs. Muir, Mavor & Coulson, Limited, previous to that date. Of the commencement and details of their work it is not necessary for me to trouble you. Suffice it to say that on March 1st, 1892, the Corporation purchased the plant of that company which was then supplying from John Street an alternating current at 2,400 volts on the mains. These mains were all overhead, and the lamps were supplied at 100 volts, the pressure being reduced by means of a transformer in each consumer's premises. On the date of the purchase there were 36 consumers, taking current equivalent to the supply of 5,000 8-C.P. 33-watt lamps. The Board of Trade granted permission to the Corporation to continue the use of these mains on the condition that they should all be removed by August, 1893.

To transfer the customers from the high tension overhead mains to the low tension underground mains was the first duty of the staff. This was done at the rate of about three per day, and John Street station was shut down on May 11th, 1893.

The site at Waterloo Street station measures about 31 yards by 31, and contains 972 square yards, having Waterloo Street to the north, Mains Street to the west, and Wellington Lane to the south, and a tenement of offices on the east side.

The building stands on a layer of concrete two feet thick, laid throughout the entire block. The main building stands fronting Waterloo Street, and covers half of the ground. It consists of the engine room, first floor with offices and workshop, and second floor with laboratory, drawing office, meter room, and cable floor. Behind the main building is the boiler house, with the battery room above it.

Boilers.—These consist of six marine type steel boilers, measuring 12 feet long and 10 feet in diameter, working at a pressure of 160 lbs. They have each two furnaces of the corrugated type, with an internal diameter of 3 feet. The fire grates are 5 feet long. There are 194 wrought-iron lap welded tubes in each, 2¾ inches external diameter and 8 feet 6 inches long, between the tube plates ⅛th-inch thick, stay tubes ½-inch thick. A steel steam drum, 5 feet long by 18 inches diameter, is on each, with two 5-inch stop valves.

There are two Tangyes (steam 7-inch, water 4½-inch) pumps, each capable of delivering 4,800 gallons per hour, either through a Wright's feed heater or direct. There is an injector connected to the cold feed capable of delivering 5,000 gallons per hour. The water tank has a capacity of 3,500 gallons. The steam pipes are 7-inch and 8-inch diameter, steel, lap welded, with wrought-iron flanges screwed and brazed.

In the engine room the steam main forms a complete ring, slung by means of rods from cast-iron brackets. Four of the boilers have a

duplicate connection to this ring, the remaining two have one connection.

Engines.—These are Willans central valve compound engines.

Dynamos.—The dynamos are two-pole, shunt wound, with drum armatures. They are coupled direct to the engines, with a heavy disc to ensure steadiness in the running. The combined plant stands on one sole-plate. The maximum output of the several dynamos is:—

Two	330 ampères,	140 volts,	92,400 watts.		
„	400 „	230 „	184,000 „		
Three	670 „	230 „	462,300 „		
Two	980 „	230 „	451,200 „		

making a total of 1,189,900, or 1,190 units.

Accumulators.—A set of accumulators is placed over the boiler house. This position keeps them in a suitable temperature; otherwise during the winter they would be affected by frost.

The set consists of 114 cells, 57 being placed between the negative wire and the middle, and 57 between the positive and the middle. Each cell has 61 lead plates, with a capacity of 1,000 ampère hours at 2 volts, with a discharge rate of 200. There are 6 cells as repair cells, or as they are sometimes called, milkers. From these, plates are taken to replace faulty ones in the working set, and should a cell show any weakness it is not allowed to discharge for a day, but is short-circuited by two milkers in series. It has thus 4 volts across it.

The battery regulating switches are placed in the battery room, and controlled by bevelled gearing from the switchboard.

Distribution.—The distribution begins practically at the switchboard. It is generated at from 210 to 230 volts, and is kept constant at the feeding points at 205, or 102 on each side of the system. The balance is maintained in the station by means of two 100-volt machines. The difference in current between the two sides does not generally exceed 200 ampères at any load. Exceptional nights have been known, such as 650 ampères, when both machines had to be run on the one side.

I have also noted the ratio between the ampères of current applied for and the maximum output. In December it was 54·3, and February 37·1. The real efficiency of running is shown in the plant load factor, which in February was 68·5 per cent. It has been as high as 71 per cent. This factor is the ratio between the output and the possible output if the machines were run full load from the time each one is started till stopped. This is the percentage that tells on the costs of running, fuel, water, oil, &c.

The underground work in the streets is, I presume, pretty well known to you. The copper strip is laid on porcelain insulators in iron culverts, which are watertight. I do not mean that under a pressure they would keep out water, but owing to their construction, the lids overlapping the culverts, the ground in which they lie must be flooded before the water could rise high enough to enter through the seam. I have never known an instance of water in the culverts. Water does collect in the brick junction boxes, especially in Bath Street, and the districts where we have heavy clay soil. Provision is made in all such for their thorough drainage. Where it is not possible to lay copper strip, India-rubber covered cables have been laid in cast-iron pipes.

The joints, which are perhaps the most important in the cable mains, are all vulcanised, thus making them equal to new cable. It may be interesting to you to learn that I have some of the India-rubber cable placed underground that was used by Messrs. Mavor and Coulson overhead, and purchased by them five years ago. It seems as good, and tests as well as new cable.

Faults in the underground mains are easily found by means of a compass needle. The needle is placed on the faulty conductor and brought to be parallel with it by means of a strong directing magnet. The other conductor is flashed to earth, and the direction of the excess current due to the fault is noted. In this way it is easily traced. Nearly all the faults are caused by careless workmen. The last fault was in Renfield Street, on the middle wire, and was traced in half an hour.

There are now 382 consumers, who have applied for a current of 15,487 ampères, which represents roughly 46,460 eight C.P. 33 watt lamps, distributed somewhat as follows:—

	Shops.	Warehouses.	Offices.	Churches.	Private Houses.	Clubs, Hotels, and Theatres.
No.	242	21	91	3	12	13
Ampères,	7,776	2,690	3,269	229	275	1,258

I have endeavoured to lay before you in as concise a form as possible a description of the works and plant in use at the Corporation electric lighting station. We have not had a year's run yet, and it is, therefore, impossible to give figures as to cost of production, &c.

Mr. Mavor said that although he considered the system adopted by the Corporation unsuitable for the work to be accomplished, he wished to compliment Mr. Arnot on the successful starting of the Glasgow electrical station, and to say that, watching critically the result of their work, he could do nothing else than say that it had been so far successful, and that the Corporation were giving the public a thoroughly satisfactory supply of electricity. The company with which he had been associated had the honour of applying for a provisional order before the Glasgow Corporation did so. In doing so they worked out a scheme for the lighting of Glasgow which differed very materially from the one now being carried out. The principal difference was that they considered that in attacking the problem of lighting the city, they must look at it not so much from the immediate position as from the probable future requirements of such a city as Glasgow. Now, that was a very large and difficult problem, and in making up their minds on the subject they devoted much care to the question, and used, as much as possible, the experience which had hitherto been gained upon this point. He regretted to say that Lord Kelvin diametrically differed from them, although he was their consulting engineer, as to the advisability of using high tension alternating currents. He would not attempt to discuss the reasons here, but he thought it was not difficult to see why the Glasgow Corporation were advised to adopt continuous currents in the circumstances in which they were placed. As Mr. Arnot had pointed out, the Corporation allowed a very large amount of the two years allowed by the Board of Trade to elapse before they took any steps in the matter at all, and it had to be admitted by the most ardent advocates of the alternating current system that it was not then so well developed as the continuous current systems for application to public lighting. A very large amount of work had been done by the Glasgow Corporation on a system almost precisely similar to that adopted in America by the Edison Illuminating Company. They had done an amount of work which was enormously greater than anything done in alternating currents, and the experience gained handicapped the alternating currents in the race, because they were later in coming on the field; but in these days he thought no one would venture to dispute that the high tension alternating current was making its way forward, and that the engineers who had the necessary experience to enable them to compare it with low tension continuous currents thought that the day was not very far distant when no one would hesitate to use high tension alternating currents in districts which were so eminently suited for such an application as the district which the Glasgow Corporation had undertaken to light. He thought it would be evident to all engineers present that there was something wrong, when the Glasgow Corporation, having undertaken to light not only the compulsory area (which is really all they had been compelled to consider up to this time), but the whole Royal Burgh of Glasgow, already in their first winter, had nine separate engines running in the station. Not only that, but the station, as at present constituted, could not be very much increased in size. The answer to that was, that another one would be started, and that it was better not to have too many eggs in one basket. Various other reasons which had a certain amount of cogency were pleaded in excuse. There was a limit to the size of the stations, it was true, but there was also a limit to the possibility of starting electrical factories all over a city like Glasgow, and it seemed reasonable to suppose that in lighting a city like Glasgow, they should look to the experience of gas distribution as a guide to what they might do with electricity. He contended that there should be as many stations for electric lighting as gas works at present, because the problem was the same. He hoped at next meeting to bring forward some considerations which might interest the institution with regard to some of the points Mr. Arnot had mentioned, especially with respect to the load curves, and to the efficiency of the engines. These were very interesting points indeed, and, after all, were the centre of the matter. It would be evident to any one who looked at those curves that to use steam engines, or any other source of power, for the production of electric lighting was not an economical thing to do, and all that could be done, as Mr. Arnot had pointed out, was to run the engines at full load for only a very short period of their existence. The rest of the time they were standing idle and doing nothing. That was a kind of industry which was not a paying one, and therefore strenuous efforts had been made to find some means of storing the work of the engines so as to apply it to the circuit when the load curves reached that very high peak which occurred during the greater part of the winter between five and six o'clock in the evening. The attempt to do that had been so far unsuccessful. The use of accumulators was indicated in that diagram by the blue lines, and they would see how very small a part they played in the operation of the station. It was totally insignificant as compared with the work done by the engines, and, although they were useful in their way, he thought that on the whole the practice adopted in America would be followed in this country, and that batteries would not be used in lighting stations. There were some other points that he would beg respectfully to differ with Professor Kennedy upon in his arrangement of the switchboard. It seemed to him that his arrangements of the switchboard were very complicated—it seemed to him partly owing to the use of batteries, which led to more complication than was warranted by their use in working. Perhaps Mr. Arnot would be good enough to say what was the maximum loss in the feeders. He mentioned that under certain circumstances it was 25 volts or 12½ per cent., or thereby. Now, that was another matter which meant a considerable amount of complication on the switchboard. If there was a loss of 12½ per cent. between the generating plant and the most distant part of the system, that loss had got to be compensated for in the engine room, and as the loss varied with the load the compensation would vary, and that necessitated constant watchfulness on the part of the attendant, and was one of the reasons why the continuous system was more difficult to work than the alternating current system. As to question of the relative cost of high and low tension systems, this was a battle that had yet to be fought out, and had to be won by one side or another. There were many cases where continuous currents had a superiority over alternating currents, but the case in question was, in his opinion, not one of these. The published figures of relative costs of lighting stations were interesting in this way—they proved that the first cost of an installation of continuous currents was greater than the first cost of alternating currents per lamp, but that the cost of working the continuous system was less than that of working the alternate current system per unit, and in balancing these two it was very difficult indeed for the most ardent partisan of either system to find very much to say on the question of economy, so that the thing resolved itself into a matter of convenience; and, fortunately, now-a-days there was plenty of opportunity for gaining the experience that would determine which was the more practically convenient. There was an element in this question which was specially interesting to Clyde engineers. Professor Biles in his paper, recently read to this Institution, pointed out that there was a possible limit to the size and speed of ocean steamers. It therefore might come to be a question whether the

Clyde engineers might not take up the construction of large land engines on marine lines. This had already been done to some extent, and it might be interesting to Clyde engineers to know that experience showed that the use of alternating current tended to increase the size of the engines used. The Waterloo Street station was a very good object lesson on this point. There were already nine engines in this station, producing a total horse-power of something under 2,000, whereas the speaker thought that it was not too much to expect that the lighting of a city like Glasgow would ultimately give employment to engines of such powers as 10,000 horse, rather than the small units now employed.

ELECTRICAL INTERFERENCE PHENOMENA SOMEWHAT ANALOGOUS TO NEWTON'S RINGS, BUT EXHIBITED BY WAVES ALONG WIRES.*

By EDWIN H. BARTON, B.Sc., late "1851 Exhibition" Science Scholar. Communicated by Prof. Arthur W. Rücker, M.A., F.R.S.

1. The preliminary paper† on this subject gave the results of a single experiment, and approximately accounted for them by a mathematical theory of the phenomena involved.

2. The present paper discusses the question of disturbances, and gives nine experiments. Two of these are similar to the first experiment, but were made under better conditions; the others were made either to lead to these improved conditions or in confirmation of the original fundamental conclusions.

3. The disturbances alluded to arise from the fact that the electrical waves are not suddenly lost after their first incidence upon the abnormal part of the secondary, but course to and fro until they die out. A method of avoiding the greatest disturbance due to this cause is pointed out and adopted. A correction is also calculated and applied for another disturbance which still remains.

4. The chief experiment‡ is on interference phenomena, somewhat analogous to Newton's rings, by transmission. The resultant curve§ depends upon about 200 electrometer readings.

5. The experiments conclude with two examples‖ of modifications of the secondary which produce *no* reflexion. These consisted respectively of thinner wires nearer together, and of thicker wires further apart, than the normal spacing. In each case the capacity was practically unaltered by the change in the wires; hence, as anticipated from the theory, no reflexion occurred.

6. The systematic comparison of theory and experiment, made¶ near the end of the paper, does not exhibit an absolute quantitative agreement. Nevertheless, the two are so far concordant in all their general features as to be mutually confirmatory, and were approved by Prof. Hertz** as close approximations.

LEGAL.

Wise *v.* Metropolitan Electric Supply Company, Limited.

(*Continued from page* 488.)

On Friday morning, April 27th, Mr. Beale, Q.C., continuing his argument for the defendants, said they had shown that they had exercised such discretion as ought to have been exercised, with their knowledge of the nature of the works, in selecting the site. They put the works on the site of some old stables, and consulted the agent of Lord Portman as well as the vestry, and no objection was raised upon the ground that it was not a proper site. They had not shown negligence in choosing the site or in the construction of the works, there had been no disposition to economise at the risk of nuisance, and in fact they had done everything they possibly could to prevent a nuisance. It was suggested in the course of cross-examination that they might stop the nuisance by putting up more engines on another site; they were asked whether they had not room for more engines at Paddington, without regard to the area covered from that station. How did they know, if they did remove to Paddington, that they would not be involved in the same difficulty they were now under, and that other people would not complain in the same way that the plaintiffs in this case were now complaining?

Mr. Vernon Smith followed on the same side, submitting that it was rather a case for damages for injury to business than for an injunction. Looking to the evidence, he did not think it was proved that the plaintiffs suffered very serious loss in consequence of the noise and vibration; some customers no doubt did not return, but most of the plaintiffs had said they still let their rooms to some extent. Therefore such loss as they had sustained was a matter which could be met by damages, and he asked his Lordship to regard the balance of convenience and inconvenience in the case, by giving the plaintiffs their remedy through the award of damages and not by granting an injunction.

Mr. Graham Hastings, Q.C., replied for the plaintiffs. He submitted that they ought to have damages, and they ought to have an injunction. Having read the cases bearing upon the point as to what constituted a nuisance, notably the definition of Lord Selborne in Fleming *v.* Hyslop, "whatever causes material discomfort and annoyance for the ordinary purposes of life," counsel argued that there was distinct evidence of nuisance and also of loss of business, and in one case, loss of health in consequence. He asked for an injunction, and that it should not be suspended for any long period, in view of the fact that his clients were still sustaining injury from the continuance of the vibration.

Mr. Justice Stirling, in giving judgment, said this was an action brought by five plaintiffs, who were tenants and occupiers of houses in Manchester Street, Manchester Square, against the Metropolitan Electric Supply Company, who had erected works for the supply of electric lighting in the immediate neighbourhood of the plaintiffs' houses, and it was sought to restrain the defendants from carrying on their business in such a way as to cause a nuisance to the plaintiffs by three different modes, namely, vibration, noise, and by causing smoke and smuts. The defences which were put forward by the company were twofold: first, it was said that they did not carry on their business in such a way as to cause an actionable nuisance to the plaintiffs; and secondly, that even if they did, the remedy of the plaintiffs was by compensation under Section 17 of the Electric Lighting Act, and not by way of injunction, and damages in an action of this sort. With reference to the second of these points he considered it unnecessary for him to go into the subject, because it had so happened that, this case having been commenced last Sittings, and there being no time to prosecute it to a termination, in the meantime the same point had been raised upon the same Acts and practically the same Order before Mr. Justice Kekewich in a case which he heard at the commencement of these Sittings, and which was decided a few days ago. He (Mr. Justice Kekewich) had considered fully, in his judgment, the legal question; he had dealt specifically in that judgment with most of the substantial points which were raised by Sir Richard Webster, and if there were a few points which were not touched upon, it did not seem to him that they would have affected the conclusion at which the learned judge arrived. Therefore it seemed to him that it would not be right that he should enter into the question again, and he should proceed on the basis of the conclusion at which the learned judge arrived on the question of law. He therefore started with this assumption, that the defendants were not entitled to carry on their works in such a way as to cause a nuisance to their neighbours; and starting from that point, there were two points which he had to consider, first of all, whether a nuisance in the legal sense was caused by the works of the defendants, and secondly, if so, what was the remedy of the plaintiffs in respect of it. He had before him the correspondence which had passed between the plaintiffs and the officers of the company, and he found that so early as January 13th, 1890, Mr. Grant, one of the plaintiffs, wrote to the company complaining of a nuisance by reason of the vibration. Then in February, 1891, Mr. Barrell wrote to Mr. Bailey, also complaining of the vibration. Notwithstanding these letters, Mr. Bailey appeared to have been of the opinion that there was nothing in the complaints, and he stated very candidly in the witness box that it was not until October, 1892, that he began to believe that there was anything in them. Having at last, after constant complaints, come to the conclusion that they had some foundation, he set to work to investigate the subject, and he stated that at about that time he reported to his board, and was instructed to take every possible means to overcome the cause of complaint. The result of Mr. Bailey's enquiries was that he discovered that the works were not situated on absolutely solid ground. It was found that somewhere about from 10 to 12 feet below the floor of the engine room there was a stratum which was variously described by witnesses as spongy clay or mud, or saponaceous clay. That stratum extended to a depth of 23 feet, and it was discovered that, at all events, when that stratum became charged with water it was of an elastic nature, and that the engines and alternators which were employed in the manufacture of the electrical supply transmitted their vibrations through the solid bed of brickwork and concrete on which they were placed to this lower stratum, and that then they were propagated to the houses of those who were now complaining. The plan which he (Mr. Bailey) suggested, and which was adopted under the advice of eminent engineers, to remedy this effect, was to place underneath the solid bed of brickwork and concrete columns reaching down to the solid London clay, some 23 feet below the termination of the uppermost stratum, which was supposed to be solid, and on which the brickwork and concrete rested. These were cast-iron columns filled with concrete, and one was placed between every two engines. These works were completed in November of last year, and it was stated that they cost somewhere about £2,000. But, unfortunately, it had turned out that even this did not put an end to the vibration. The question arose, what was the reason of that? and the answer which was given by the defendants' witnesses, Mr. Bailey, Prof. Kennedy, and Dr. Hopkinson was that although what might be termed the vertical vibrations had been stopped by means of those pillars, the horizontal motion was not stopped; that was to say, those pillars, solid though they were, did yield to a certain extent in a horizontal direction, moving as an inverted pendulum would do, from the bottom of the column—the bottom of the column being fixed, the top gave way to a certain extent, and horizontal vibrations were still transmitted through the stratum of spongy clay. Now, the further question arose, could this be remedied? The witnesses whom he had mentioned agreed that probably it could. All of them very properly

* Abstract of paper read before the Royal Society. Received February 20th, 1894.

† *Roy. Soc. Proc.* Vol. liv., pp. 85—96, 1893.

‡ Expt. v, arts. 42—48.

§ Curve E, fig. 10.

‖ Expts. VIII. and IX., arts. 51—62.

¶ Arts. 63—77.

** Under whose able guidance the work was carried out in Bonn, 1892—93.

admitted that the problem they had to solve was a new one, and they could not speak with absolute certainty on such a question, but if they were correct in the view they entertained as to the origin of the vibrations which still existed, then they would in all probability be stopped by placing at the top of the columns slanting struts in such a way as to stop that horizontal vibration. A pair of such struts had been placed in position, but they were not absolutely completed or effectively connected with the columns at the present time, but it was said that they would be completed in a short time. It was further proposed, if that were not found sufficient, to absolutely stop the vibration, to put in further struts at different points. But the important point to be considered was this, that it was admitted on all hands—defendants' witnesses did not dispute it—that vibration did exist in those houses, and it might be taken as a fair conclusion from the evidence that there was a substantial amount of vibration existing in those houses due to the working of defendants' engines. All the scientific witnesses gave their evidence with the greatest possible fairness—and among them he included Mr. Bailey—and he did not propose to go through that part of the evidence, as to which there was no question. But did this vibration constitute a nuisance? That was the next question he had to decide; and the test to be applied was that suggested by Vice-Chancellor Knight-Bruce, in Walter *v.* Selfe, and by Lord Selborne in the House of Lords. Did it cause material discomfort or annoyance for the ordinary purposes of life to those houses, and to the business of lodging-house keepers carried on there? In beginning to consider the evidence upon this point, he would remark that the question was put to Mr. Bailey as to whether he considered these complaints were in any way unfounded; and although he thought some of the statements were slightly coloured and exaggerated, he did not seriously dispute the general accuracy of the evidence. His Lordship then read portions of his notes of the evidence given by the several plaintiffs, and by their lodgers, remarking that whilst they spoke very forcibly as to the vibration, which was the first ground of complaint put forward, and evidently felt it to be a real grievance, he was not much impressed with the manner in which they gave their evidence as to noise, which seemed to be rather an appendix to the vibration, as sometimes a complaint about air was added to a complaint about light. But as to the vibration, it did seem to him that the witnesses gave their evidence with great moderation, and without any serious exaggeration. It might be that there was a little colour here and there, but substantially the case of the plaintiffs as to the interference with the comfort of the houses as the effect of the vibration was made out. He could not come to the same conclusion as regards either the noise or the smuts, which he did not think was a serious part of the nuisance. He accepted entirely the statement made by Mr. Bailey that during the coal strike they were unable to get the proper and usual coal, and were compelled to burn coal of an inferior quality, which did produce a certain amount of smoke, but there was certainly no case made out for an injunction upon this head, nor did he think there was any case made out as to damages. But that was a small part of the case, and he did not think any serious expense had been incurred in consequence of the mention of noise and smuts. It did seem to him that there was substantial interference with the houses and businesses of lodging house keepers carried on by the plaintiffs, and that that ought to be ground for an injunction, and also an inquiry as to damages. But it was said on behalf of the company that if an injunction were granted it ought not to be put in immediate operation. He was entirely of that opinion. He thought the company had been unfortunate. It was not necessary for him in the view he had taken to go into the question of negligence, and he should say nothing upon that; but he certainly thought that since October, 1892, when the attention of the engineer was first seriously directed to the matter, they had done their very best to remove all ground for complaint on the part of the plaintiffs, and if they had not succeeded up to the present time it was not attributable to any negligence on their part, but to the fact that they had had to deal for the first time with a very difficult question. He thought the company ought to have a fair opportunity of completing the works upon which they were now engaged, and which there was reasonable hope would entirely prevent the nuisance, and they certainly ought to have a reasonable time allowed them for that purpose. Having regard to the difficulty of the subject, he thought it would be a fair thing to suspend the operation of the injunction for three months at least, and that would give them an opportunity of bringing the matter before the Court before the Long Vacation if, unfortunately, the efforts of the engineers did not meet with success. He proposed, therefore, to grant an injunction as regards vibration only, an inquiry as to damages on that subject, and to suspend the operation of the injunction for three months.

Mr. Graham Hastings asked for costs on the higher scale, as the questions dealt with were difficult ones.

Mr. Justice Stirling said the question which the advisers of the defendants had to determine was a difficult one, but he did not think the question before the Court was such as to require costs on the higher scale.

Muirhead *v.* Commercial Cable Company.

Justice Kennedy's Decision.

In the Queen's Bench Division of the High Court of Justice on Saturday last, Mr. Justice Kennedy delivered his considered judgment in the case of Muirhead *v.* The Commercial Cable Company. The trial of this action occupied his Lordship, sitting without a jury, for seven days in March, and at the close of the arguments the Judge reserved his judgment. The claim of the plaintiffs was for £3,566 for royalties due under an agreement giving the defendants the right to use certain patents belonging to the plaintiffs for the transmission of messages simultaneously in opposite directions over the same conductor. The defendants paid £135 13s. 5d. into Court for royalties to July 1st, 1891, and denied further liability. They also pleaded that on July 1st, 1891, the English, French, and Canadian patents came to an end.

Mr. R. B. Finlay, Q.C., Mr. Bousfield, Q.C., M.P., and Mr. E. H. Pollard, appeared for the plaintiffs, instructed by Messrs. Trinder and Capron; Sir Richard Webster, Q.C., M.P., Mr. J. Fletcher Moulton, Q.C., and Mr. A. J. Walter, instructed by Messrs. Budd, Johnsons & Jecks, were counsel for the defendant company.

Mr. Justice Kennedy, in delivering judgment, said the action was brought under an agreement of January 2nd, 1884. At that date the defendants were about to lay and work certain submarine cables, and the purpose of the agreement was to secure to the company in the establishment and working of their cables the use of the patented apparatus and the improvements on that apparatus. By the terms of the agreement certain specified royalties were to be paid quarterly. The first article of the agreement said: The inventors granted to the company the right to apply their patented duplex apparatus to their cables, and the grant was made for the whole period during which the patent should last. For the purpose of this case it might be taken that this agreement was until June 24th, 1891; at all events it had been carried out both by plaintiffs and defendants up to that date, but the royalties since that date had not been paid by the defendants. If the right to these royalties existed, there was now no dispute as to the figures; but the pecuniary importance of the action went beyond these figures, because if the plaintiffs were entitled to any royalties at all, they were entitled to quarterly payments for the years succeeding 1891. The issue of the action could be summed up in a single sentence: "Was the patent, No. 223,490, granted to the plaintiff, Alexander Muirhead, on November 16th, 1880, in the United States, a patent which was lasting after July 1st, 1891?" The plaintiffs contended it was. If it was not, the defendants were entitled to judgment. But simple as the statement of the issue was, the determination of it involved some important questions of law, and more difficult questions of fact of a scientific and highly technical character. The patent was granted by the Patent Office of the United States for the term of 17 years from November, 1880. *Primâ facie*, therefore, it would last until November 16th, 1897; but being a United States patent, it was governed by the law of those States. It was part of the statute law of the States that every patent granted for an invention which had been previously patented in a foreign country should be so limited, as to expire at the same time as the foreign patent. This statutory provision would be found in the 29th Rule of Practice of the United States Patent Office. It had also been decided in the Courts of the States that although a United States patent had not, upon its face, a limit within the 17 years, nevertheless by operation of law, if the invention had in fact been previously patented abroad, and the foreign patent expired before the 17 years term had run out, the United States patent expired at the same date. It was further, in his opinion, the law of the United States that where a grant had wrongly been made for a term exceeding the duration of the foreign patent, it was not necessary, in order to determine the rights of the patentee and prevent the exercise by him of the privileges of the grant, that any judicial proceedings should be taken for the purpose. By operation of the statute the United States patent was extinguished and expired, notwithstanding the terms of the grant, when the foreign patent expired. That being the state of American law as to patents, the defence to this action was that the invention for which the United States patent of 1880 was granted was "an invention which had been previously patented in a foreign country;" the foreign patent in this case being the English patent granted in 1876, No. 2,564. The defendants contended further that the patent of 1876 expired not later than July 1st, 1891; consequently the United States patent of November 16th, 1880, although containing a grant for 17 years from that date also expired at the same time, and, therefore, as after July 1st, 1891, there was no patent which was lasting within the meaning of the agreement between the parties, the obligation of the defendants to pay royalties then ceased. The learned judge proceeded to review the arguments put forward at the trial by the plaintiffs and defendants, and after doing so, said he was pressed to hold that, sitting in England, he could not find the United States patent had expired without proof of a decision of a United States Court to that effect. That was put by counsel for the plaintiffs rather on the ground of convenience. He suggested a hardship for the patentee on the ground that he could, when sued in this Court, have placed himself in safety as he could have done if sued in the United States, as regarded the identity of the 1880 patent, by disclaiming part of the later patent. The possibility and undesirableness was also pointed out of a conflict of judicial decisions—the American Court holding that the patent was good, while the English Court had held it differently. This form of answer to the defendants' contention was inadmissible. The action was brought on an agreement, and was properly brought in an English Court. By the 9th article of the agreement itself, it was provided that this contract should be construed as an English contract, and all questions arising under it should be determined by an English tribunal. The parties had bound themselves, therefore, to submit to the English Court. The question to be determined on the agreement was whether the American patent was or was not a lasting patent after a certain date. He could not properly refuse to try that question, because it involved matters of United States law relating to patents. It was clear to him that he must deal with this question as other questions of foreign law were constantly dealt with in the courts of this country. The materials for forming a judgment on the foreign law had been put before him. He now came to the consideration of that which appeared to him the most difficult—the question of fact. Were the defendants right in their contention that Muirhead's American patent of 1880 had been granted for an invention which

had been previously patented in England in 1876? Unless the defendants were right in this, the defence to the action wholly failed, and the plaintiffs were entitled to his judgment. In order to enable him to form a conclusion upon this issue, which involved considerations of a scientific and highly technical character, he had had adduced before him on each side a great body of most valuable scientific evidence. He had also had, and desired to make acknowledgment of it, very great assistance from the counsel engaged in the case, including the excellent model constructed by Mr. Walter. There were three points of American law he had to notice. Firstly, there was the principle laid down by Judge Cox in the British Electric Company *v.* Junior Electrical Company and others, tried in New York in 1890. The principle laid down there was identical with the English law, that a patent ought never to be declared invalid because of the expiration of a foreign patent if there is a doubt as to the patent being the same, the doubt should always be in favour of the patent. The second principle was that laid down by Justice Bradley in Siemens's Administrator *v.* Sellars, in relation to the case of an American patent containing improvements on an earlier patent. The third principle was as to the test of identity between the subject matter of the two patents. He found that the test had been different in the American cases brought under his notice. Applying this knowledge to the present case, he thought the proper test of identity would be:—Is the principle of the invention of the patent of 1880 found in the English patent of 1876; is the subject matter of the one the same in all essential particulars as the other; or would a structure made pursuant to the patent of 1876 infringe the American patent of 1880; would a skilled person, after reading the description of the invention covered by the English patent of 1876 be enabled to construct the apparatus described in the American claim of 1880? It appeared to him (Mr. Justice Kennedy) that these were the principles adducible from the American decisions relative to this case. He had kept these principles in view in the consideration which he had given to the contents of the patent itself, and to the scientific evidence adduced at the trial in regard to the terms and subject matter. The claim of the 1880 patent was, in his judgment, a claim of the narrowest kind, effecting, as the patentee alleged, "new and useful improvements in duplex telegraphy." There was no claim made for any of the structural elements of the combination beside the combination. Admittedly all these elements, taken separately, were old. The patentee said his invention related to duplex telegraphy, and to the class worked on the bridge or differential system; the object of the invention was to reduce the retardation of signals, and he obtained his end by certain novel combinations and organisations of old instrumentality. The defendants, in order to succeed, had to show that this particular combination of old instrumentality—the working of which undoubtedly had produced better results than had ever been obtained before—was to be found in the English patent of 1876. Put shortly, the distinction appeared to consist in the method and means of adjustment, or, as it was called by some of the expert witnesses, the method and means of establishing and maintaining the necessary balance. According to the evidence, by the introduction of that method and means the patentee had been enabled, whilst obtaining the necessary facility for keeping and maintaining a balance, to get that which was necessary for speed—a reduction of the resistances in the bridge arms. He was satisfied by the evidence of Lord Kelvin, Mr. Bottomley, Prof. Silvanus Thompson, and Dr. Hopkinson, that the introduction of the rheostat alone placed at the apex of the arms of the bridge, and therefore in such a position as not merely to afford an easy and sufficient means of varying the resistance so as to get a ratio which gave a balance, but also to maintain the sum of the resistances of the two bridge arms constant, was a very important part of the 1880 combination. He did not find any combination containing that element in the patent of 1876. The battery, the key, the receiving instrument and its condensers—all these were to be found in the 1876 patent, but he did not find there was any means and method of adjustment, which, in his opinion, formed the important part of the patent of 1880. On the contrary he found in the 1876 patent means of adjustment of a much more clumsy and complicated nature, and were incompatible with the use of a low resistance rheostat. It was said by the defendants that some method of adjusting the resistances in the bridge arms was essential, and that the adjustment of the bridge arms was a common method in 1876, and the rheostat as a ready means of adjustment was well known in 1876. They said that the author of the 1876 patent ought to be treated as implying in the combination the use of a rheostat of the kind, and in the position described in the patent of 1880. Such a doctrine of implied claim ought in any case to be applied with the greatest possible caution. The danger of its working injustice to inventors was obvious. In this case he certainly could not apply it. The argument against such an implication did not, on the evidence rest there. He had to consider the fact that the application of duplex telegraphy to long submarine cables was, in 1876, in its infancy, and that improvements in this branch of applied science had been obtained and could be obtained only by experiments. Messrs. Muirhead's themselves said that in 1876 they did not dream of the possibility of such a combination as shown in their patent of 1880. He (the Judge) had clearly come to the conclusion that the combination patented in the United States in 1880 was a new invention, and was not the invention for which the English patent of 1876 had been granted. Tested according to the principles enunciated in the American cases, it seemed to him that the allegation of identity of the patents upon which the defence was based had failed. He held that the patent of 1880 was, at the date when the payments claimed fell due, a lasting patent, and he therefore gave judgment for the plaintiffs for the amount claimed with costs.

Mr. Finlay: That will be judgment for the plaintiffs for £3,566 and interest since the money was due.

Mr. Justice Kennedy: I have not considered the question as to whether you are entitled to interest.

It was arranged that the question of interest should be argued on another day.

Electric Construction Corporation and the South Staffordshire Tram Company.

In the Chancery Division on Wednesday, the petition of Mr. Alfred Dawson and others for the winding up of the South Staffordshire Tramways Company came before Mr. Justice Vaughan Williams.

Mr. Herbert Reed, Q.C., and Mr. B. Davis appeared in support of the petition, Mr. Buckley, Q.C., appeared for the company, Mr. Warmington, Q.C., represented debenture holders, while Mr. Bower appeared for Mr. Ebbsmith, of the Electrical Corporation, and formerly solicitor to the Tramways Company.

Mr. Reed said this petition for winding up was presented by shareholders on the ground that it was just and equitable the company should be wound up. The company was incorporated by the South Staffordshire Tramways Act, 1889. Prior to this there had been an older company, known as the South Staffordshire and Birmingham District Steam Tramways Company, Limited. The effect of the Act of Parliament was to dissolve the old company, incorporate the new company, and invest the assets of the old company in the new. The capital of the new company was £86,580 preference shares, £129,150 ordinary shares, and mortgage debentures to the extent of £50,000. The company had paid no dividends since 1887, and in April, 1893, a debenture holders action was commenced, under which, with the consent of the company, receivers and managers were appointed, consisting of Mr. Sully and Mr. Carruthers Wain, the chairman of the company. The only way, now, to safeguard the interests of the shareholders was to have an investigation, a winding up, and a reconstruction. Many of the acts of the receiver and chairman of the company were called in question, and, amongst other things, he had been a party to issuing debentures. The great bulk of the debentures issued were outside the powers of the company. The old company had as chairman Mr. Carruthers Wain, and, as solicitor, a gentleman whose name was Smith, but who had since assumed the name of Ebbsmith. During the career of the old company this solicitor appeared to have had very great power over the affairs of the company, and the affidavits showed acts done by Mr. Ebbsmith which certainly pointed to a greater regard for his own interests than the interests of the company for whom he was solicitor. In 1889 a company was formed, called the Electric Construction Corporation. It was promoted by Mr. Ebbsmith and another gentleman. The chairman of the tramway company, Mr. Wain, was also interested in the concern. Mr. Smith was the managing director. The petition stated that these persons put forward the Electric Corporation as an independent body, and held out to the shareholders of the tramway company that the directors were dealing with the corporation so as to get the best terms they could for the company. All this was most illusory. The real facts were concealed from the shareholders. The shareholders had no means of knowing the exact terms on which these gentlemen stood to the corporation. A contract was entered into with the Electric Corporation in February, 1892, which, if continued, would in the opinion of the petitioners result in the ruin of the company. This contract was made between Mr. Wain, on behalf of the company, and Mr. Smith, on behalf of the Electric Corporation; about that time Mr. Smith had retired from the position of solicitor to the tram company. By the contract the Corporation were to let cars to the company, and the company were to issue £15,000 in debentures. Royalties were to be paid to the Electric Corporation at the rate of 9d. per mile up to 250,000 miles, and 6d. per mile beyond. The corporation were to pay the company's debts up to £4,000. This contract was to continue for five years' service, and at the end of the five years the company was to take over the cars at the sum of £15,000. But there was a provision that, in certain circumstances, the corporation should be at liberty to cancel the agreement, the company to pay the corporation 4½d. per mile, the difference between the number of miles actually run and 1½ millions of miles, and also to pay the purchase money, £16,000. The evidence showed, beyond question, that first of all 9d. per mile was a most extravagant charge, 4d. per mile being the usual price paid. There was no possibility of the company finding this £16,000, and there was very little probability of their ever working up to the minimum of 250,000 miles. The evidence showed that last year this number of miles was slightly exceeded, but the additional number had involved very great cost, and the proceeds from the traffic was very, very small. The shareholders whom he represented submitted that the contract was an improvident one, entered into under peculiar circumstances by Mr. Wain, chairman of the company, and Mr. Smith, chairman of the other company. In May, 1893, there is a debenture-holders action, and Mr. Wain and Mr. Sully were appointed receivers for the debenture holders. These receivers had taken no steps to modify the contract, save for a reduction for the time from 9d. to 6d. The shareholders alleged that the directors acted in their own interests and not in the interests of the shareholders. Among the debenture holders were holders for £750, issued in respect of a patent protector—a guard, or a sort of cow catcher, which was fixed to the tramcar for the purpose of removing any child on the line in danger of being run over, and gently tipping it into the roadway. This patent came into question in rather a remarkable manner. Mr. Dickinson was assistant engineer of the company, and experiments were made by him at the cost of the company. The protector was patented and the right to use it sold to the company, and £750 debentures were issued in respect of it to a corporation called the Corporate Trust. The Corporate Trust was Wain and Smith. Dickinson's Tramways Appliance Company, Limited, was promoted by Mr. Smith, who bought the patent from Mr. Dickenson for £55, and sold it to the company for £750. Mr.

Smith was the only shareholder in this company with the exception of the seven signatories. Mr. Dickinson had an inventive mind which was able to produce appliances which suited every company with which Mr. Smith was connected, but which were not found necessary on any other tramway in the kingdom. The Appliances Company made considerable profit; the old company alone paid them upwards of £500, and £750 was issued to a nominee of the Corporate Trust. Between February, 1889, and October, 1892, £4,980 was paid to the Appliance Company in respect of Dickinson's invaluable appliances. In his affidavit Mr. Wain had descanted with great appreciation upon Dickinson's appliances, and said no tramway was complete without them, but he omitted to mention any single tramway in the kingdom other than that with which he was connected, which used his appliances. His Lordship would see that this payment, if it was not corrupt, was at all events a fortunate advantage for Mr. Wain and Mr. Smith. Among other matters, the question arose in the earlier history of the company of the carriage of goods, and subscriptions were invited from the public to provide equipment for goods traffic. In 1887 it was known that the local boards would not authorise any goods traffic. That fact had been persistently concealed from the shareholders. In these circumstances the company had the good fortune or otherwise to acquire certain land of Mr. Smith's at Wednesbury. Mr. Smith let the land to the Appliance Company, who covenanted to erect buildings to the amount of £3,000. Then that land was sold to the Tramways Company for the purpose of a goods depôt at the price of £7,122, of which £4,000 was paid by bills of exchange, £100 also being paid to the Electric Appliance Company. This was then, and was now, waste land. The explanation now was that the company had bought the ground as building land, though there were only about 30 houses altogether built at Wednesbury, and notwithstanding that the company had surplus land which they could have dealt with. These were matters requiring investigation. On another feature of the case, his affidavits showed that the meetings of the shareholders were inconveniently arranged, and the shares were so distributed as to favour the management of the company's business by the directors. In order to get a quorum they actually hired saloon carriages to take voters from London to Birmingham for the shareholders' meeting at Darlaston, and paying their expenses at the hotel. They held the meeting at the most inconvenient place, and when shareholders arrived they found the room full, and could not get in. At the present there were two directors, one having died, so that there was not a quorum of directors. The learned counsel concluded by intimating that it might be necessary to apply that the parties should be called for cross-examination.

Mr. Bower said he appeared for Mr. Ebbsmith, to protect him against attack.

His Lordship: It does not appear to me that you have done that. (Laughter.)

Mr. Bower said he meant when his opportunity came. It was the fact that Mr. Ebbsmith had brought an action for libel against these parties, and apology had been made to him.

Mr. Bramwell Davis read affidavits filed in support of the petition.

Mr. Justice Williams: Do you agree, Mr. Buckley, that what I have to try is a question of facts?

Mr. Buckley: As regards many of the so-called facts, I think my friend has been indulging in romance.

Mr. Justice Williams: Then whether he has been indulging in romance or not it is a question of fact.

Mr. Buckley: I say he has failed to make out a case.

Mr. Carrington said he appeared for 375 shareholders, who were entirely of opinion that it was contrary to the interests of the company that this petition should be proceeded with.

Mr. Buckley, in opposing the petition, said it was true the company had failed to pay interest on the debentures, and the debenture holders had stepped in and got a receiver and manager appointed.

Mr. Justice Williams: Therefore the management of the company is not in the hands of the proper officers, and as you cannot resort to domestic liquidation, that is a strong case for winding up.

Mr. Buckley said his point was, that if the undertaking was continued it might result in something better for the shareholders. With regard to the contract in question, the Tramways Company had to give up steam traction because of the complaints of the local authorities as to the smoke and noise. Several electrical companies were communicated with, and ultimately the contract was made with the Electric Construction Company. He was in a position to put evidence before the Court to show that this was a perfectly proper and prudent contract for the company to make. The learned counsel read an affidavit by Mr. Wain, the chairman of the Tramways Company, in which that gentleman said four companies were approached before the Electric Construction Company, and it was only because the Electric Corporation offered terms more favourable than the other companies that the contract with them was made. The great difficulty was, the Tramways Company had no cash, and none of the other companies were willing to do the work without cash. Ninepence per mile included not only the cost of traction, but also for repayment of part of the capital. The contract was made on such terms that the Tramways Company would ultimately become prosperous. Mr. Wain said the contract was, in his opinion, more favourable to the tramway company than the Electric Corporation. The allegation as to the directors taking certain shareholders to the meetings by saloon carriages was denied; the shareholders were conveyed in the ordinary way, and there was no packing the meetings. Eminent electrical engineers had expressed the opinion that the contract was very favourable to the tramway company, and the tramway company was now beginning to earn a profit. The petitioners had come here to present a case of fraud against the directors, but the petitioners' case had failed altogether. The charges of fraud could not be supported.

The hearing of the petition was adjourned.

On Thursday morning, after some discussion, Mr. Justice Williams suggested that the debenture holders should do something to give the shareholders a voice in the management of the company.

Mr. Bramwell Davis said the shareholders would be satisfied if the chairman of the board was removed, and the shareholders got an efficient voice in the management.

His Lordship eventually directed the petition to stand over until next Law Sittings, and in the meantime a meeting of shareholders was to be held in London to determine whether the shareholders wished for a winding-up order or not.

BUSINESS NOTICES, &c.

Electrical Affairs in St. George's, Southwark.—There is a probability of litigation between the Vestry of St. George the Martyr, Southwark, and the London Electric Supply Corporation. Ever since the company commenced operations in the parish, there has been a dispute as to the reinstatement of trenches, the company originally holding that it should be allowed to employ whom it liked to do such work, and the vestry contending that only the contractor who reinstated trenches (at an agreed price) after the gas and water companies, should be employed. A dispute has now arisen between the company and the vestry over an account for trench work done, and as attempts to arrive at an amicable settlement have failed, the vestry has intimated to the company that it will now take legal steps to recover the money it holds to be due to the parish.

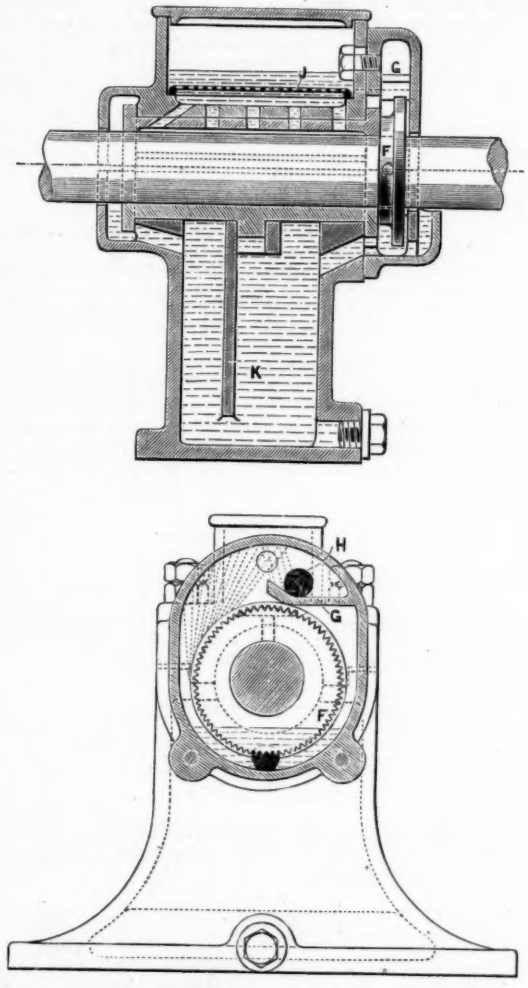
The County of London and Brush Provincial Electric Light Company recently wrote to St. George's Vestry, informing that body that they had obtained subscriptions for £200,000 worth of fresh capital, and asking the vestry to kindly intimate to the Board of Trade its satisfaction regarding the financial condition of the Brush Company, as required by Section 7 of the Southwark Electric Lighting Order, 1892. The company also wrote to the Board of Trade, pointing out that about £40,000 of its capital was paid up, and that by four quarterly calls of £2 per share upon the shareholders, the remainder of the capital would be in hand by March 30th, 1895; whilst the amount of money expended in connection with the issue of capital, the expenses of obtaining provisional orders, and certain investments in the shares of the Dover Electricity Supply Company and the Bournemouth and District Company, was about £25,000. The completion of compulsory works under the order would cost about £15,000. The Board of Trade has forwarded this letter to St. George's Vestry for its comments, and pointed out that the company is also liable to the extent of about £120,000 for the completion of compulsory works in other London parishes. The Vestry of St. George, Southwark, at its last meeting, came to the conclusion that there was need to be careful in arriving at a decision whether or not to oppose the company coming into the parish, and the matter has been referred to the General Purposes Committee for careful consideration and report.

The Birmingham City Council and Electric Lighting.—The General Purposes Committee have reported as follows with reference to the Birmingham Electric Light and Power Order, 1894:—With reference to Council minutes referring this order to your committee, they report that the areas over which the company propose to extend their powers are practically the same as those embodied in their application of 1892, and referred to in your committee's reports of December 6th, 1892, and July 25th, 1893. The draft order, as submitted by the promoters, did not appear to your committee to give sufficient advantage to the public in return for the important concessions sought by the company. They therefore instructed the Town Clerk to lodge a notice of objection on behalf of the Corporation, with the Board of Trade. A copy of this notice having at the same time been sent to the promoters, negotiations took place between them and your committee, with the following result: (1) The authorised maximum price for electric energy to be reduced from 10d. to 8d. per Board of Trade unit; the minimum charge per quarter being reduced from £3 10s. to £3 6s. 8d. This to apply to energy supplied under the existing orders of 1889 and 1891, as well as to that to be supplied under the new order. (2) The promoters to be compelled to lay mains in certain streets in each area agreed to by your committee within two years from the confirmation of the order. (3) The clauses of the Board of Trade model order with respect to street boxes, supply of energy to owners and occupiers, and to public lamps, &c., to be inserted. The promoters have agreed to these conditions, and as time was pressing, your committee, in pursuance of the authority given them by the Council, have, subject to the insertion of clauses in the order for carrying out the foregoing arrangements, given the necessary consent to the application.

Country House Lighting.—Mr. C. D. Harrod, Somerset, is about to instal the electric light in his new country mansion at Morebath. Major-Gen. Webber, C.B., has been appointed to plan and superintend the work, and he has accepted the tender of Messrs. Stenner & Co., Fore Street, Tiverton, to supply all the plant, dynamo, and motive power and carry out the complete installation. Apart from extras, the installation will cost between £500 and £600.

Messrs. Drake & Gorham have obtained the contract for the lighting of Greenway House, the country residence of Mr. T. B. Bolitho, M.P., by means of about 120 lights. It has been decided to put down a petroleum engine of the very latest pattern, and an Electric Construction Company's shunt-wound dynamo to charge 53 "D.P." accumulators.

New Self-Oiling and Filtering Pedestal.—Below we illustrate a new self-oiling and filtering pedestal, invented by Mr. Straker, of Messrs. Straker, Whitworth & Co., of Cannon Street, E.C. The pedestal shown has been designed for the Electric Construction Company. The oil flyer, F, is a disc milled on its periphery and fixed to the rotating spindle or shaft. This disc slings the oil off tangentially into the cup, G, from which it flows into the orifice, H, through the oil strainer, J, into the bearing. The used oil drains into the reservoir, K, where it mixes with the clean oil and thus a continuous circulation is effected. The journal working under a head of oil is in a continuous state of being flushed on the oil bath principle. In some recent extensive experiments carried out by the Institution of



Mechanical Engineers, it was shown that the comparison of the friction of the different systems of lubrication employed, was as follows:—

	Actual load in lbs. per sq. in.	Coefficient of friction.	Comparative friction.
Oil bath	263 ...	·00139 ...	1·00
Syphon lubricator ...	252 ...	·00980 ...	7·06
Pad under journal ...	272 ...	·00900 ...	6·48

The pedestal is perfect acting for all speeds over and above 200 revs. per minute, and is said to work efficiently for months without replenishing or attention. Messrs. Siemens Bros. & Co., the Electrical Construction Company, and a large number of leading firms are constructing these pedestals, under license, for dynamos, motors, and shafting, and Messrs. Straker have also a large number at work on other high-speed machinery. We understand that Messrs. B. Verity & Sons (Manchester branch), are the firm's north country agents, and they hold a number of these pedestals in operation ready for inspection.

Mr. Charles H. Northcote asks us to mention that he is acting as agent in conjunction with Messrs. Verity for the sale of the bearing in the Manchester district. After having made some very careful tests with the bearing, they have adopted it on a number of installations, including bearings and pedestals, in connection with five dynamos which they are installing at the Blackpool Tower.

Electric Light in Leather Works.—The electric light has been adopted in the leather dressing works of Messrs. E. Turney and Co. and Messrs. Bayley & Co., Nottingham. In both cases the installations have been placed in the hands of Messrs. W. J. Furse and Co. of that town, who have adopted the E.C.C. dynamos, the power being derived from Tangye's horizontal steam engines.

Kingston Electric Lighting.—Application is to be made to the Local Government Board for permission to borrow additional capital of £6,000 for electric lighting purposes, in order that increasing demands for the current may be met. In the original estimate laid before the council for electric lighting works and installation, no sum was included for house connections and meters supplied to consumers; part of the £6,000 is required for these things. A second item is to be expended on the purchase of a small dynamo and engine, which have already been authorised by the council. With these in hand the Electric Lighting Committee assert they would be able to supply all day time consumers by a smaller plant than at present, and they would thereby be enabled to save coal. A third item is for an additional cable to be laid in Thames Street, where the demand has been so heavy that the present cable is not able to provide a sufficient amount of current. A fourth item is for completion of the plant so as to make it sufficient for all present necessities. The existing plant is turning out all the current it is capable of producing without trenching upon the stand-by engine and dynamo. There are over 3,000 lamps in use, and the main portion of them being in shops, are burning at one time, and the plant is no longer sufficient to thoroughly cope with the demands for the light, which are said to be increasing day by day. Therefore it will be found necessary before next winter to put down a larger dynamo and engine. The dynamo would cost about £1,100 or £1,200.

Electricity as a Motive Power in Holland.—The Government of Holland invited last year plans and tenders for the construction and delivery of the motive power for the new sea locks of Ymuiden, the seaport of Amsterdam. The plant, says *Engineering*, was to consist of the machinery for 12 lock gates, 24 sluice valves in these gates, 12 sluice valves for bypasses, and 12 capstans. Machinery for the lighting by electricity of the surroundings of the locks was also to be provided. The subscribers were at liberty to tender either for electric or hydraulic machinery. In all some 13 plans were submitted, viz., eight for hydraulic machinery, four for electric machinery, and one for compressed air machinery. The Government have now decided that none of the plans submitted are entirely satisfactory as they stand, but have nevertheless purchased the following schemes:—For electric machinery: 1. The plans of Messrs. Gebrs. Figee, engineers, of Haarlem, and Mr. P. H. ter Meulen, electrical engineer, of Amsterdam, agent of the Electrizitäts-Actiengesellschaft, formerly Messrs. Schückert & Co., of Nürnberg, Germany, for the sum of 1,200 gilders. 2. The plans of Messrs. Siemens & Halske, of Berlin, for 700 gilders. For hydraulic machinery: 1. The plans of Messrs. C. Hoppe, engineers, of Berlin, for 1,200 gilders. 2. The plans of Sir W. G. Armstrong, Mitchell & Co., Limited, of Newcastle-upon-Tyne, for 700 guilders.

Fareham Electric Lighting.—A public meeting was held at Fareham last week to consider the Fareham Electric Light Company's offer to sell the business and undertaking to the Local Board. Mr. Blake, one of the directors of the company, gave statistics showing an increase on the business of about 100 per cent. on 1893, as compared with 1891. He estimated that the purchase of the business and laying down a mile of underground wires and a duplicate engine and dynamo, would involve an expenditure of about £8,000, and that the works, if taken over by the Local Board, would practically pay their way after the first year or two. A proposal in favour of the Board purchasing the works was negatived by a large majority, whereupon a poll was demanded.

Catalogues, &c.—Mr. A. G. Inrig, of Antwerp, has brought out a catalogue describing the various machines and electrical goods supplied by him. The Brussels, Antwerp, and other dynamos, also arc lamps, switches, lamp sockets, distribution boards, electric measuring instruments, glass ware, electroliers, and a variety of artistic lamp fittings are illustrated in this book.

We have received from Messrs. Bowker Bros., of Preston, a sheet illustrating, and otherwise describing, their patent safety electroliers, wall and pillar brackets and cluster fittings.

From Messrs. Chas. Joyner & Co., of Birmingham, we have received a price list of the "Ventilator" counterweight.

Lynton Electric Lighting.—Mr. Benn attended the last meeting of the Local Board and explained that he was parting with his electric lighting works to a company who were prepared to give a more efficient light by obtaining greater water-power. They proposed erecting a storage tank on Summer House Hill capable of giving a two days' extra supply. He asked the Board whether they would be willing to resume the lighting contract with the company for 14 years. It was resolved that on the Board being satisfied that the additional works are satisfactory and the lighting efficient, they would extend the lease as requested.

Electric Light at Bridlington.—At the meeting of the Bridlington Local Board last week, Mr. Rennard said he hoped if the committee decided upon lighting the sea front with the electric light, on the underground system, they would get on with the work as quickly as possible, and lay the pipes before the asphalting was done. Mr. Wentworth said the lighting of the sea front was receiving due consideration and the suggestion made by Mr. Rennard would not be lost sight of.

Derby Electrical Exhibition.—An electrical exhibition will be opened at the Mechanics' Institute, Derby, on May 14th, by the Mayor. All the most modern appliances and apparatus will be exhibited, and demonstrations given in electrical cooking, heating, &c. In connection with the opening, Sir Frederick Bramwell will lecture on the subject of "Electricity." The electrical power in connection with the exhibition will be supplied from the borough electric lighting station.

Waterloo Bridge Lighting.—At Tuesday's meeting of the London County Council, Colonel Ford presented a petition from the ratepayers of North Lambeth calling attention to the Act of Parliament passed last Session providing for the lighting of Waterloo Bridge by electricity, and praying that the Council will no longer delay carrying out the work. The petition was referred to the Highways Committee.

Electric Lighting at Brighton.—The Lighting Committee have received six tenders for the supply and erection at the Northroad works of two engines and dynamos with necessary accessories, the amounts ranging from £5,550 to £6,503. The lowest tender, that of Messrs. Crompton & Co., Limited, is recommended for acceptance.

Personal.—Mr. Reginald H. I. Drummond, A.M.I.E.E., has been appointed chief electrician in the Madrid station of the Electricity Supply Company for Spain, Limited. He was formerly in the City of London Electric Lighting Company's station at Bankside, S.E., in the capacity of an assistant electrical engineer.

Newark and the Electric Light.—Some of the tradesmen met the other day and discussed the electric lighting question. The general feeling of the meeting was in favour of the Corporation taking up the matter and pushing it forward rapidly. A resolution referring the matter to the Corporation's prompt attention was passed.

Electric Lighting in Holland.—The lowest tender submitted to the Municipal Authorities of Rotterdam for the establishment of an accumulator station in connection with the electric lighting station was that of Messrs. Hofman, of Kralingen, namely, 33,200 florins.

Church Lighting.—Considerable alterations have been made in the electric lighting of St. Paul's Church, Knightsbridge. All the pendants for lighting the nave are now fitted with 32 C.P. lamps. Messrs. Allpress carried out the work.

Business Announcement.—The Hayesmoore Company inform us that they have opened works for the making of electrical specialities at 10, Union Mews, Union Street, W., 53, Crewdson Road, Clapham Road, S.W., being now their head office.

Mill Lighting.—Messrs. Bennett & Druce have been instructed by Messrs. Tootal, Broadhurst, Lee & Co., Limited, of Bolton, to entirely reorganise the electric light installation at present erected in their extensive mills.

Amble and Electric Lighting.—A local paper understands that a contract has been entered into for the renewal of the electric light plant at the Harbour, the old plant having become worn out.

Electric Lighting in Australia.—The Municipal Authorities of Ballarat, Victoria, have recently decided to postpone the consideration of the electric lighting question until they see how the system works in Melbourne.

Montrose and Electric Lighting.—The Town Council intended visiting Coatbridge electric lighting station last Monday in connection with the proposed introduction of electric lighting into Montrose.

Bournemouth Electric Lighting.—The Bournemouth Electric Supply Company have notified that after May 1st a large section of the district supplied by them will have a continuous day supply.

Electric Light at Burton-on-Trent.—Dr. Mason has decided to adopt the electric light for his new house and museum. The installation has been placed in the hands of Messrs. W. J. Furse and Co., of Nottingham.

Portsea and Electric Lighting.—The Board of Guardians have decided to have their offices lighted electrically and tenders are to be invited for the work.

Bradford Electric Lighting.—The Gas and Electricity Supply Company last week instructed their electrical engineer to draw up plans for an extra lighting station at Frizinghall.

Thetford and Electric Lighting.—The Town Council have resolved to light St. Peter's clock electrically.

The Telephone at Bristol.—Last Friday the National Telephone Company opened for service a new switchboard at Bristol.

CONTRACTS OPEN AND CLOSED.

OPEN.

Cairo.—July 1st. For the construction and working of the first tramways to be established in Cairo and its environs; traction to be either by electricity or by animals; deposit, £E1,000. Tenders to the Minister of Public Works, Cairo.

Braila.—May 21st. Fresh adjudication of works relative to the lighting by electricity and gas of the town of Braila. Application to Mayor's office, Braila.

Ille-sur-Têt.—June 29th. Tenders for the lighting of the town by electricity. Applications to the office of the Mayor of Ille-sur-Têt, Pyrénées-Orientales.

CLOSED.

Bath.—Six tenders were received for wiring the municipal buildings in accordance with the specification. The lowest was that of Messrs. Wenham & Waters, of Croydon, at £245, and this has been accepted.

Worcester.—The Council have accepted the tender of the Brush Electrical Engineering Company to lay the necessary mains for fixing 26 15-ampère alternate-current arc lamps in High Street, the Cross, the Foregate, Foregate Street, St. Swithin Street, Mealcheapen Street, and Broad Street, and the necessary lamp posts, lamps, &c., at the price of £1,861. The Council have also resolved to apply to the Local Government Board for their sanction to the loan of £1,861 required.

FORTHCOMING EVENTS.

Monday, May 7th.—Society of Arts, at 8 p.m. "Typewriting Machines," by Henry Charles Jenkins, A.M.Inst.C.E. Cantor Lecture II. Requirements that a type-writing machine should meet—Later attempts to satisfy these—Type-bar and type-wheel machines—Keyboards and changes of "Case"—Alignment—Supply of ink to type—Inspection of the writing—Spacing of the letters—Stenographic machines.

Wednesday, May 9th.—Society of Arts, twenty-first ordinary meeting, at 8 p.m. "Telegraphs and Trade Routes in Persia," by Col. Wells. Sir Frederic J. Goldsmid, K.C.S.I., C.B., will preside.

Thursday, May 10th.—The Institution of Electrical Engineers at 25, Great George Street, Westminster, S.W. Ordinary general meeting at 8.0 p.m. Continuation of discussion on Mr. R. E. B. Crompton's paper on "The Cost of Electrical Energy."

BOOK RECEIVED.

Electric Light Installations. Vol. ii. By Sir David Salomons, Bart., M.A. Seventh edition; revised and enlarged. Published by Messrs. Whittaker & Co., Paternoster Square, E.C.

NOTES.

Worthing and Electric Lighting.—The Town Council have instructed the Clerk to make enquiries of other towns regarding electric lighting.

Wanted!—A firm of London electrical contractors have had a very amusing enquiry regarding a machine required for the Indian market. An Indian customer wants to know the price of a machine which "(1) gives electrical shocks and sends out sparks; (2) is a magic lantern of sorts; (3) can make any noise desired, and can ventriloquise. The name of the instrument has been forgotten." It is evident that somewhat exaggerated ideas are abroad in India as to the wonders of electricity.

Gas v. Electricity in the City.—At the last meeting of the Commissioners of Sewers Mr. Ross, reporting on the number and cost of the gas lamps displaced by the arc lamps in the main thoroughfares, said the electric lights, numbering 479 arc lamps, cost £12,454 per annum, whereas the 1,315 gas lamps cost, for lighting and maintenance, £4,631 per annum. Mr. McCarthy, commenting upon the enormous increase, asked whether the Commission intended lighting the side streets by electricity, which would cost another £10,000 a year. Mr. Burmester said the Streets Committee was considering that point.

Electric Light at Derby.—The Local Government Board have sanctioned the borrowing of £5,000 for the extensions of the electric lighting of Derby, repayable in 20 years. Between October 10th and March 31st the amount due from customers for electrical energy was £474 7s. 10d., and the estimated amount due for street lighting was £505 15s. It is intended to supply the electric light to the two police stations and the Market Hall.

The Phonopore Company.—The report of this company, which we present to our readers on page 525 of our current issue, is very deplorable. It would be interesting to learn the candid opinions of Mr. Spagnoletti and Dr. Silvanus P. Thompson, on what the chairman calls little more than a pretty electrical toy. The back numbers of the ELECTRICAL REVIEW will be found to contain opinions not much at variance with that of the Chairman.

Bill for Exempting Tenants Machinery from Rating.—The second reading of this Bill stands for Wednesday next, May 9th, and it is of the greatest importance that a large majority should be obtained in its favour. The Machinery Users' Association would like our readers on seeing this to at once write in their own interests to their Members of Parliament pointing out the necessity of attending and voting in favour of this Bill. Letters to be effective should reach members not later than Monday morning.

The Quackery Crusade.—From a paragraph in the *New Zealand Herald*, we gather that medical electricians passing as "Professors" are busy in that part of the globe as well as over here. The paragraph does not go into detail, but we are impressed with the idea that the "Professor" is a quackery imposter.—"Some excitement has been occasioned here (at Nelson) in connection with 'Professor' ——, the medical electrician. H. S., who was employed by the Professor till a few days' ago, made public statements regarding his late employer of a damaging nature, and Mr. B ——, C.E., went to the platform, and said he was asked by Professor ——, who was not present, to state that he would completely answer H. S. on Sunday next, and asked the people to withhold their judgments till then. This afternoon, however, the 'Professor' left for the South and Invercargill. Some have threatened to bring an action against him. Mr. B —— appears to have been set upon after he left the meeting, and assaulted."

The New Pacific Cable.—Advice from British Columbia is to the effect that the Pacific cable scheme has met with the entire approval of the legislature, and a motion has been adopted accordingly. The *Canadian Gazette*, in a leading article last week, takes Sir John Pender to task for his depreciatory statements regarding the proposed cable, and the no-cause-for-fear attitude which he took up before the shareholders of the Eastern Extension Telegraph Company some days ago. Sir John is, without doubt, a cable monopolist in his views, and it is but natural he should exert his influence in the interests of the shareholders of his various companies. There is perhaps no one in this country who has had such lengthy and varied experience in cable matters as has Sir John Pender. We cannot, however, agree with him when he declares the proposed cable a "piece of sentiment." Our own opinion is that feeling in favour of, and the necessity for the cable is so strong, that in a very short time the Eastern Extension Company will have to fight a competitor not of the weakest. Sir John makes very stirring speeches to his shareholders, but as he addressed the Extension Company proprietors the other day, we could not help thinking that beneath all the feelings to which he gave expression there lurked a dread fear of the competition. At the forthcoming conference to be held at Ottawa, Lord Rosebery intends a representative of the British Government to be present; but until after that conference he will not commit himself to anything in the way of subsidies. Meanwhile the Sir John Pender group are, as we have already stated, using every endeavour to oppose the new scheme. But the Government, in considering such opposition, must take note of the fact that the line is wanted for the good of the community at large and the colonies, whereas it is opposed by a section of people who, for a number of years, have enjoyed an exclusive monopoly, which has returned very fair dividends. Public opinion in the Australian colonies in favour of the proposed Pacific cable is growing in strength. It is felt that, sooner or later, the cable will have to be constructed, possibly under conditions which may be less favourable to the Colonies and Great Britain than the cable now proposed, which would only touch British territory, and would be controlled by British influence.

Refuse Destructors and Steam Generating.—The report of the Hull Committee, on page 528, forms interesting reading matter. It is evident that the Committee consider the Livet system to be behind the means employed at Leeds and other towns for the disposal of refuse, and we can only conclude that one or more of its members must possess some technical knowledge, or that all of them were convinced of the truth of our own articles on this topic. More light on the chloride of lead cells is awaited by many besides the Hull Committee, but if we are not much mistaken the result will be very different from preconceived hopes. In the meantime we would call attention to the article dealing with these batteries, on page 508, from the pen of Mr. Andreoli. We cordially endorse the recommendations of the Hull Committee, but we venture to warn them against any lingering idea that the waste heat of destructors will ever be available for the production of an electrical supply on a large scale from central stations for regular lighting purposes.

Continental Electrical Tramways.—The recognition of the great importance of the electric working of tramlines by the electric works which supply energy for lighting purposes is gradually finding more appreciation. In Hamburg, the consumption of the tramline already amounts to a fourth of the total demand, and Aix-la-Chapelle has decided to work its tramline electrically, and to obtain the current from the electrical works installed by the joint stock electrical company formerly known as Schückert & Co., of Nürnberg. The length of the line which will first come into operation is about 24 kilometres. When the suburban lines are connected, the diameter of the net will be 30 kilometres. For the existing track there will be substituted a double line. The hilly character of the ground is unfavourable for the work; gradients of 5 per cent. are frequent, and the maximum incline reaches 8 per cent. The system is overhead, with supply by means of trolleys. Of the 34 cars, 19 will have motors of 15 H.P., in order to be able to take up extra cars; the others will have motors of 10 H.P. The entire electrical contracts will be carried out by the company mentioned above, in a similar manner to the line already completed at Zwickau, and the line from Baden to Vöslau, which is approaching completion.

Electricity in Harbour Construction.—A paper was recently delivered before the Cleveland Institution of Engineers, at Middlesbrough, by Mr. W. Kidd on "Bilbao Harbour Works." He stated that in the construction of the various breakwaters, &c., it was in 1888 decided to adopt electricity for working all the plant required for the making and handling of the concrete blocks, and to this end a special travelling crane, transfer table, and loader were designed. The dynamo supplying the electric current for working the block-handling machinery was worked by the 60-horse-power compound workshop engine. The author described at length the travelling crane for moving blocks in the yard, the travelling crane on the loading staiths, the barges, and the electric "Titan" for building the superstructure. He stated that the electric plant had proved remarkably economical, it being claimed that though probably only 55 per cent. of the power supplied to the dynamo was obtained in useful work, still the power was supplied by an economical engine, which would not be the case if each separate machine had had, as usual, its own engine and boiler. The maintenance was practically nothing, the chief expense being new brushes every three months; the commutators also required turning up about twice a year. The electric "Titan" for building the superstructure consisted of two steel main girders 103·9 feet long, 14·7 feet high, and spaced 12·3 feet apart, centre to centre. The main girders were strongly braced together by cross girders, which divided the height into three stages or decks, which formed the platforms upon which the various constructive operations could be effected. On the lower stage was a concrete mixer, which could be traversed in either direction for a distance of 65·8 feet. It was worked by a 12,000-watt compound-wound motor. The striking feature in the construction of these extensive works was the large use of electric plant, and the success with which it had been applied to the lifting and transport of heavy blocks, concrete mixing, &c.

Darlaston and Electric Lighting.—The Local Board have started to consider the question of electric lighting. An electrical engineer is to be consulted upon the whole matter.

"Industries and Iron."—We understand that *Industries and Iron* has been purchased by Messrs. Cordingley and Co., of 39 and 40, Shoe Lane, E.C., the proprietors and publishers of *The Laundry News* and *Sugar*.

Personal.—Mr. John B. Verity, of Weybridge Heath, Surrey, and Aston, Warwickshire, has recently been sworn in as a Justice of the Peace for the County of Warwick.

Owing to the change in the proprietorship of *Industries and Iron*, Mr. C. H. Yeaman ceases to act as editor.

B.Sc. Degree in Engineering.—The Edinburgh University Court, at their last meeting, decided to recognise the day lectures and laboratory courses given by Prof. Andrew Jamieson, at the Glasgow and West of Scotland Technical College, as qualifying *pro tanto* for their degree of B.Sc. in engineering.

Electric Light at Bristol.—A Local Government Board inquiry was held on 25th ult. regarding the Council's application to borrow £24,650 for electric lighting. £9,468 represents additional expenditure in making the installation over and above the original estimate, and the £15,181 is to be expended on new works for extended installation. The authorities have resolved—subject to the application for the £24,000 loan being sanctioned—to extend their mains to Redcliff Hill, at a cost of £855.

Fleet v. Astor.—A libel action, arising out of the famous series of articles which appeared in the *Pall Mall Gazette* some months ago regarding Harness's electropathic belts, was heard at the Law Courts on Wednesday and yesterday. Mr. Augustus Fleet, who was referred to in the articles, claimed damages for libel from Mr. Astor and the *Pall Mall Gazette*. Mr. Justice Wright heard the case, and a jury gave a verdict, carrying costs, we believe, in favour of the defendant, Mr. Astor. We have great pleasure in congratulating Mr. Astor and the *Pall Mall Gazette* upon the victory gained. The race is not always to the Fleet!

Destructive Fire in Montreal.—Telegrams dated 2nd inst. from Montreal, state that while the Earl of Aberdeen was reviewing the fire brigade in the Champ de Mars yesterday afternoon a destructive fire broke out in the Royal Electric Works. Owing to the firemen being in full dress for the parade some delay occurred before they set to work to subdue the flames. Lord Aberdeen accompanied the men to the scene of the fire. Twenty-five dynamos were destroyed, and when the fire was at its height the fly-wheel of the largest engine burst, the heavy fragments crashing into the surrounding buildings. There was no loss of life, but many remarkable escapes are reported. The loss of property is estimated at over $100,000.

British Association 1894 Meeting.—The annual meeting of the British Association for the Advancement of Science is this year to be held at Oxford, from August 8th to 15th. The first general meeting will be held on Wednesday, August 8th, at 8 p.m. precisely, when Dr. J. S. Burdon Sanderson, M.A., M.D., &c., will resign the chair, and the Marquis of Salisbury, K.G., D.C.L., &c., President Elect, will assume the presidency, and deliver an address; on Thursday evening, August 9th, at 8 p.m., a Soirée will be held; on Friday evening, August 10th, at 8.30 p.m., a discourse will be delivered by W. H. White, Esq., C.B., F.R.S., on "Steam Navigation at High Speeds"; on Monday evening, August 13th, at 8.30 p.m., a discourse by Prof. J. Shield Nicholson, M.A., on "Historical Progress and Ideal Socialism"; on Tuesday evening, August 14th, at 8 p.m., a Soirée will be given; and on Wednesday, August 15th, the concluding general meeting will be held at 2.30 p.m. The different sections will assemble in the rooms appointed for them, for the reading and discussion of reports and other communications, on Thursday, August 9th; Friday, August 10th; Saturday, August 11th; Monday, August 13th; and Tuesday, August 14th, at times fixed by the Organising Committees.

Toxteth Workhouse Lighting.—A Committee of the Guardians has been appointed to consider the desirability, &c., of lighting the workhouse with the electric light.

Ipswich and Electric Lighting.—The Corporation have resolved to apply for a provisional order, and an Electric Lighting Committee has been formed to follow up the matter.

Liverpool Overhead Railway.—The Liverpool Overhead Railway extension to Seaforth Sands Station has been inspected by Major-General Hutchinson and Major Cardew, R.E., and passed for public traffic. The extension opened to the public on Monday.

Wolverhampton Electric Lighting.—At last week's meeting of the Lighting Committee of the Wolverhampton Corporation, it was decided that the foundation stone of the electric lighting works in Commercial Road should be laid on Monday, May 21st.

Central London Railway.—The Unopposed Bill Committee of the House of Commons on Tuesday passed the Bill of the Central London Railway, under which an extension of time is granted until 1900, within which to complete and open this authorised undertaking.

Folkestone Electric Lighting.—At a mass meeting of ratepayers and others held at Folkestone last week, a resolution was carried emphatically protesting that the scheme for lighting the borough with electricity, at a cost of £35,000, was extravagant and ill-advised, and calling upon the Corporation to abandon the scheme.

NEW COMPANY REGISTERED.

Californian Electric Power and Mining Development Syndicate, Limited (41,043).—This company was registered on the 28th ult. with a capital of £30,000 in £1 shares, to purchase and turn to account any mines, mining claims, or alluvial ground; to make arrangements concerning electric power or lighting works, telegraph and telephone lines, cables and works, railways, tramways, and other means of communication of a similar nature; and to carry on any metallurgical operation. The subscribers (with one share each) are:—Wm. Edward Savory, 84, Beresford Street, S.E., clerk; J. T. Thompson, 116, Nevill Road, Stoke Newington, N.; O. Stockman, 58, Georges Road, Leyton, gentleman; W. H. Glencross, 2, Drylands, Road, N., Gentleman; A. E. Walton, 8, Draper's Gardens, E.C., mining engineer; T. E. Candle, 8, Draper's Gardens, E.C., mining engineer; H. H. Frost, 14, Dumont Road, N., gentleman. Many of the regulations of Table A apply. Registered by Williams & Neville, 23, Austin Friars, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

General Electrolytic Parent Company, Limited.—The registered office of this company is, says a notice filed at Somerset House on December 14th last, now at 30, Moorgate Street (Star Chambers), E.C.

Mexican Gas and Electric Light Company, Limited (18,223).—This company's yearly return (filed April 16th, 1894), shows that the whole of the nominal capital of £100,000 in £20 shares has been taken up and paid.

Kensington and Knightsbridge Electric Lighting Company, Limited (26,193).—This company's yearly return, filed March 4th, 1894, shows that, out of a nominal capital of £350,000 in 50,000 ordinary, 10,000 1st preference and 10,000 2nd preference shares, all of £5 each, 15,000 ordinary, 10,000 1st preference and 1,466 2nd preference shares have been taken up. A sum of £5 has been called on each of the preference shares of both classes, and the full amount has also been called on 10,000 ordinary shares. A sum of £107,330 has been received, and £25,000 has been agreed to be considered as paid.

CITY NOTES.

The Phonopore Company.

The annual general meeting of the shareholders of the company was held on Monday at Winchester House, Old Broad Street, E.C., Mr. Henry Seebohm (the chairman) presiding.

The Chairman, in moving the adoption of the report and balance-sheet, said that the late board, when it took over the management of the company from the previous board, took it over with a light heart. They thought that all the difficulties had been overcome. They thought they were in an ideal position, upon which to build up a prosperous future, and that they had a large stock of excellent instruments ready for commerce. Members of the late board and electrical experts whom they consulted, especially Mr. Spagnoletti, took a very sanguine view of the company's position. They could, therefore, well imagine that, in the face of such strong evidence in favour of its perfection, it took them a very long time before they were absolutely convinced, as they were now, that what they possessed was little more than a pretty electrical toy. There were great difficulties to be overcome in the practical working of the phonopore. They were, no doubt, in an ideal position, and not in a practical one, and those difficulties were continually developing from day to day, and from week to week correspondence was laid before the board, with one almost uniform result, namely, everybody was anxious to use the instrument, and all who tried it were very much pleased with it; but by-and-by they found that the adjustment of it was so delicate that it was more than the average telegraphic clerk was capable of grappling with. The board had, therefore, constantly to send out messengers to put instruments right which, for some reason, had gone wrong. Another serious obstacle to the success of their instruments was owing to the induced currents interfering with neighbouring telephone wires, and the board was obliged, after more than a year's work, to come to the conclusion that one of two things would have to be done, either to improve the system itself or else to wind up the company, and throw the whole thing overboard as a failure. It was extremely disappointing to the board, and, as the shareholders might imagine, extremely disappointing to the late chairman of the company. Sir Mountstuart Grant Duff was absolutely convinced, as all members of the board were, that the gentleman who had reported on the future of the phonopore had taken far too sanguine a view of its capabilities, and he naturally felt, at his age, that the work was too great for him, and he was compelled to resign his seat on the board purely upon the question of extreme disappointment at finding that the statements that were made were not borne out by actual experience. He had no doubt that all those statements had been made in an absolutely *bonâ fide* manner. He had no doubt that Mr. Langdon Davies believed every word he uttered, although those statements had not been borne out by facts. He held it was merely a matter of opinion, and he did not accuse those who made those statements of saying anything which was not true; but there were certain points which were altogether incorrect, and which results had since proved to be so. For instance, Mr. Langdon Davies represented that in the year 1889 the working of the company was, on the whole, so satisfactory that there was sufficient profit made to pay all the expenditure and to carry forward £266 to the next year. The whole of that profit, and more than that, was derived not from receipts from the phonopore, but from the issue of shares at a premium, and in that year, in which the company was represented to have made £266 profit, they absolutely made a loss of £4,721, which was almost precisely the same figure as in 1891. In 1890 the loss was only £1,000, because the company had not so much money, and it was unable to spend more because it did not have it to spend. In the following years there was not a variation of more than £300 a year in the loss, and that amount of loss had been entirely owing to the fact that the company had been carrying on experiments, and had been trying to get the instruments more perfect. He was pleased to say that it had, to a very great extent, succeeded in doing so. The directors now found that when they sent out instruments they were followed by more orders, and that in itself was a satisfactory matter. Those who took the instruments were not grumbling at their imperfections, but at the price. Most of the railway companies had lost a deal of money, owing to the coal strike and other matters, and consequently their great desire had been to economise as much as possible. The directors, however, hoped that in the future the sales would continue to increase, especially as constant inquiries were being made, both at home and abroad, for the instruments. The company was now sending out people to fix up fresh instruments, and the results from those instruments had been much more satisfactory than they were 12 months ago. The directors had made several important improvements, including a new receiver and a new sounder, and they were now able to work their instrument upon a single needle key as well as on the Morse system. After alluding to the satisfactory report on the alterations and improvement in the instruments made by Prof. Silvanus P. Thompson, and circulated amongst the shareholders, the chairman stated that the directors had tested the phonopore, and were now of opinion that they had got an instrument which would meet the requirements of the market, and they hoped, therefore, that the position of the company would be better in the future than it had been in the past. The old board bought the patent rate governor from Mr. Langdon Davies for about £10,000, and they now found that there was not one instrument which possessed that rate governor, and that it was a complete failure. Although the prospects of the company were much better than they had been lately, yet the shareholders must not fancy that they were going to win in a canter. They had still got a tremendous fence before them, and it was possible that they might come a cropper before they got through. The difficulty they had to face was that there was no reasonable prospect that the money in hand would hold out until the receipts balanced the expenses. There could be no doubt whatever that in order to keep the company in a proper position fresh capital would have to be raised in some form or other. The shareholders might rest assured that the prospects held out to them some years ago were pure unmitigated moonshine. He was extremely sorry he could not lay before them a better report.

Mr. A. W. Hart seconded the motion.

Mr. Langdon Davies moved as an amendment: "That the consideration of the report and accounts for the year 1893 be deferred to an adjourned meeting, to be held within a month, and that a committee of shareholders be appointed to join the board in considering the report and general condition of the company's affairs. The directors and the committee to make a joint report or separate reports, as they think fit."

Mr. Philbrick seconded the amendment.

After a long discussion, in the course of which Prof. S. P. Thompson, Mr. Kesky, Mr. Spagnoletti, and others took part, the amendment was put to the meeting and rejected, and the resolution for the adoption of the report carried by a large majority.

Mr. M. I. Browne having been re-elected a director of the company and Mr. A. R. Ramsay reappointed auditor, a vote of thanks was given to the chairman and board.

Indo-European Telegraph Company, Limited.

The ordinary general meeting of this company was held on Thursday last week at Winchester House.

Major-General G. B. Tremenheere, who presided, said the company had had a prosperous year, having realised by way of revenue £5,380 more than in 1892. The expenses, however, had been slightly in excess. After placing £10,000 to reserve, the board recommended the payment of a dividend and bonus of 10 per cent. for the past year, carrying £6,452 forward. The work on the company's important system and on the other lines in connection therewith had been carried on with the most perfect regularity, and the average time of the messages had been eminently satisfactory. As a mark of their appreciation of the services of the staff, the board had decided to set aside £4,000 for them from revenue by way of bonus, thus celebrating the completion of the first 25 years of the existence of the company. He thought he might congratulate the proprietors on the very sound position of the company.

The report was adopted, and the dividend and bonus recommended declared.

Norwich Electricity Company, Limited.

The third annual general meeting of this company was held on the 24th ult. at the offices of the company, Queen Street, Norwich, Mr. F. W. Harmer presiding.

The Chairman moved the adoption of the report of the directors, from which the following are extracts:—

"The arrangement which had been made with Messrs. Laurence, Scott & Co., to supply electricity to those who had previously used it, and also to any who might be desirous of doing so until the new machinery was ready to start, has proved a satisfactory one, since it has enabled the company to commence operations with a sufficient number of customers to earn a profit from the very first day of its working. During the three months ending December 31st last, the amount received for current has been £805 15s. 8d., which will pay the cost of producing it, including salaries, wages, coal, and all other station expenses, the office expenses of the company for 12 months, and the interest due to the bank, leaving a balance of £237 9s. 10d., which it is proposed to carry forward. In their last report the directors expressed their belief that as soon as the works were started, the demand for light would rapidly increase; but the actual result has exceeded their most sanguine expectations. A large number of shops have adopted the electric light, but it has not as yet been introduced into many private residences. The advantages of electricity over gas are, however, almost greater in the case of dwelling-houses than in that of shops, so that the directors feel it is only a question of time before it becomes as popular in the former as it now is in the latter. A few motors, driven by electricity, are at work, but the directors believe their number will be largely increased when the advantages of using them become more widely known. The rapid progress of the company made it necessary for the directors to obtain from Messrs. Gurney & Co. a further loan of £5,000, in addition to the £5,000 previously borrowed for the purchase of the Duke Street estate. Since January, however, shares to the amount of about £5,000 have been applied for privately, and the directors are prepared to allot shares to a further limited amount, as it is clear that considerable extension will be necessary during the present year. The directors who retire by rotation are Messrs. Gilman and Colman, and they offer themselves for re-election. Mr. Mottram, the auditor, retires, but is eligible for re-election."

The Chairman said the directors would not have been surprised, nor do they think the shareholders could have complained, if in the establishment of a new enterprise like this the company had for the first year or so lost money, but so far from this being the case, although it has only been at work for three months, it has not only paid its way from the very beginning, but has even realised a substantial profit for the past year. The company had certainly made a capital start. The accounts came out better than we had any reason to expect, and we are very hopeful as to the future. We may seem to have taken a long time in getting to work, but we believe the time has been well spent. We have got the best site in the city for our central station, which is a very important matter. We have

adopted the system which we still think is the right one, and our machinery is all new and of the most modern and most approved construction. We have not, during all this time, spent a single penny that was not actually necessary. Excluding the preliminary expenses of starting the company, and of getting the provisional order, expenses which we could not avoid or control, we have spent hardly anything during the four years in which the company has been in existence that could not fairly be charged to capital. The directors have a good deal of satisfaction in pointing out that the total expenses for the past four years, with the exception of those preliminary expenses before alluded to, have been little more than £200 altogether. The adoption of electric lighting has gone on far more rapidly than we could possibly have expected, in fact, almost faster than we could deal with it. The result of our first quarter's working shows that electricity can be produced to pay a profit, and that profit can certainly be increased as the demand increases. Our present buildings and mains are able to produce and to distribute a much larger amount of current than they do at present. None of our expenses, except that for coal, will increase in anything like the proportion to an increased output. We have, during the first three months of 1894, gained many new customers, and if this is so, you need not have much anxiety as to the future of the company. We shall require more money by this time next year if the thing increases as it has hitherto done, but this will be a matter for congratulation rather than for regret. We provided a certain amount of machinery, which we thought would be ample for present requirements, but we now find it is certain that the machinery will be insufficient, and that it will be necessary for us to lay down new machinery before next autumn. We therefore propose to issue from time to time, either in shares or debentures, as we may require it, some further portion of our unissued capital. I am glad of this opportunity of explaining that the breakdown of the electric light at the evening meeting of the Town Council last week was the fault of the fittings belonging to the Corporation, and was not in any way due to any failure in the supply of current from the company's mains. In conclusion, I desire, on behalf of my colleagues as well as myself, to express the belief that it is only a question of time before we shall be able to establish the company on a dividend paying basis.

The SHERIFF (Mr. J. Barwell) seconded.

The re-election of the retiring directors was unanimously carried. Mr. J. Mottram was re-appointed auditor.

West India and Panama Telegraph Company, Limited.

THE directors' report for the half-year ended December 31st, 1893, to be submitted to the 34th ordinary general meeting on May 9th, states that the amount to credit of revenue is £34,265 6s. 4d. against £38,358 11s. 9d. for the corresponding half-year of 1892, and the expenses have been £22,602 8s. 3d., against £25,155 11s. 5d. for the same period in 1892, leaving a balance of £11,662 18s. 1d., which, with £4,137 7s. 4d. brought from last account, makes a total of £15,800 5s. 5d., with which it is proposed to deal as follows:—

First preference shares—			
Dividend, six months to December 31st, 6s. per share	£10,368	18	0
Second preference shares—			
Dividend, six months to December 31st, 6s. per share	1,400	14	0
Ordinary shares—			
9d. per share (free of income tax) ...	3,312	0	9
Balance to current half year's account ...	718	12	8
	£15,800	5	5

The traffic receipts for the six months show a decrease of £1,965 4s. 3d., as compared with the corresponding period. It will be remembered that in June, 1891, certain reductions of rates were made in the West Indies. After an experience of 2½ years it is estimated that these reductions have caused an aggregate loss of £20,863. This discouraging result again appears to show that reductions of rates on this company's system are not compensated for by any increased use of the telegraph. The cost of repairs to cables during the half-year amounted to £9,549 6s. 10d., being £2,464 0s. 5d. less than that for the corresponding period. Since the issue of the last report the company's second repairing steamer, *Duchess of Marlborough*, has been lying up in London, and up to the present the *Grappler* has dealt satisfactorily with all interruptions in the West Indies. In accordance with the articles of association, Charles William Earle, Esq., retires at this meeting, and offers himself for re-election. The retiring auditor, John George Griffiths, Esq., desires to offer his firm, Messrs. Deloitte, Dever, Griffiths & Co., for election as auditors of the company.

Brazilian Submarine Telegraph Company, Limited.

THE ordinary general meeting of this company was held on Wednesday at Winchester House, Sir John Pender, M.P., presiding. In moving the adoption of the report, the chairman stated that the receipts for the half-year ending December 31st last, were £96,262, being a decrease of £10,598 as compared with those of the previous half-year, and a decrease of £17,630 as compared with those of the corresponding six months of 1892. The average value of the Brazilian milrei was in the December half of last year, 10 1/32d., compared with 12 3/32d. and 13 3/32d. in the two previous half-years respectively. This further fall in exchange value of the Brazilian currency collected accounted in a large measure for the decreased receipts from messages. On April 1st, 1893, a reduction was made in the tariffs, and therefore the first half of 1893 contained the benefit of the higher tariffs for the first three months. The expenditure in the half-year to the 31st of December last was £24,284, or £16,296 less than that of the previous half-year, the decrease in cable repairs accounting for £14,607 of this amount. The usual interim dividends at the rate of 6 per cent. per annum had been paid; £20,000 had been transferred to reserve, while in the previous half-year they could only add £7,000 to the reserve. For the five years previous to 1893 the average amount reserved half-yearly was £43,500. The reserve fund on December 31st last amounted to £668,000, a very satisfactory sum, but it was absolutely necessary to hold it in order to provide for new cables when they were required. Their concession from the Brazilian Government would expire in December. They had had special privileges for the last 20 years, and they desired to have those privileges renewed as far as possible for another 20 years. They were sending out an agent to deal with the Government with this object. They had obtained through the Western Brazilian Company, as agents, a concession for laying a cable from Brazil to the Argentine, and this would enable them to work the competition with the American company in a satisfactory manner. They would, however, only lay this cable if they found it necessary to do so to protect their interests. The Hon. W. St. John Brodrick, M.P. seconded the motion. In reply to Dr. Trewhella, the chairman stated that after delay from unexpected causes the lines of the Pacific and European Telegraph Company between Buenos Ayres and Valparaiso were opened last March with promising results. They were now enabled, in conjunction with the West Coast of America Telegraph Company, to deal with traffic to and from Chili, Peru, and Bolivia. In this they were competing with the Galveston route, which, in like manner, competed with this company at Buenos Ayres for the East Coast traffic, particularly that of Argentina; in a lesser degree that in Uruguay; and to some slight extent that of Brazil. The motion was then adopted.

African Transcontinental Telegraph Company, Limited.—The report from December, 1892, to March 31st, 1894, states that the directors decided to construct first the 400 miles of the line between Salisbury and Zomba, the seat of Administration of the Nyasaland Protectorate, and work was commenced simultaneously from each of these places with a view to meeting at a point near Tete, on the Zambesi river. The outbreak of the Matabele war prevented the company's operations during the dry season in respect of the construction of the southern section, and since the war little or nothing had been accomplished with regard to this section, transport having been impracticable. In the northern section good progress has been made; but in February last the Portuguese officials placed every obstacle in the way of the telegraph party, declining to allow their work to proceed, and threatening violence. The directors think the action of the Portuguese is a direct infraction of the convention of 1891.

Official Announcements re Limited Companies.—Notice has been published in the *London Gazette* to the effect that the following companies will be struck off the register within three months, unless cause is shown to the contrary:—Automatic Electrical Corporation; Automatic Electric Supply Company: British Electric Propulsion and Traction Company; British Sodium and Aluminium Company; Carlton Engineering Company; Electrical Works Construction and Maintenance Company; Electro-Galvanic Machine Company; New Electro-Amalgamator Company; Otway Engine Company; Portland Electric Light Company; Syrinx Gas Engine Company; Thompson's Electrical Fitting and Screw-cutting Company; Wolverhampton Electric Light and Power Company.

Submarine Cables Trust.—The report for the year ended April 15th states that the revenue, including the balance brought forward, amounted to £22,673. The expenses amounted to £1,301, and the payments on account of coupons to £21,131, leaving a balance of £240 to be carried forward.

Consolidated Telephone Construction and Maintenance Company, Limited.—The directors recommend a dividend at the rate of £2 per cent. per annum, less income tax, for the year ended March 31st.

Stock Exchange Quotations.—Application has been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation to Waterloo and City Railway Company's shares.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending April 29th, 1894, amounted to £901; week ending April 30th, 1893, £792; increase, £109; total receipts for half-year, 1894, £15,513; corresponding period, 1893, £15,360; increase, £153.

The Cuba Submarine Telegraph Company. The estimated traffic receipts for the month of April were £3,900; as compared with £3,946 in the corresponding month of last year.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of April, 1894, amounted to £1,742, against £1,742 in the corresponding period of last year.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 27th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £2,835.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, April 25th.	Closing Quotation, May 2nd.	Business done during week ended May 2nd, 1894. Highest.	Lowest.
184,500£	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	101 —104	101 —104	...	...
1,134,640£	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	42 — 44	43 — 45	43½	43¼
2,932,680£	Do. do. 6 % Pref.	Stock	£5 5s.	£5 10s.	£5 2s.	80 — 81	80½— 81½	81¼	80½
2,932,680£	Do. do. Defd.	Stock	...	...	...	7⅜— 8¼	7⅜— 8¼	...	...
130,000	Brasilian Submarine Teleg., Ltd.	10	8 % §	6½ % §	6½ % §	11¾— 12¼	12 — 12½	12¼	12
18,700£	Do. do. 5 % Bonds	100	...	...	...	100 —103	100 —103	...	...
75,000£	Do. do. 5 %, repayable June 1906	100	...	...	...	108 —112	108 —112	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10%‖ §	... §	1½— 2½	1½— 2½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	146 —150	146 —150	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½ % §	2 % §	... §	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12 — 13	12 — 13	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18 — 19	18 — 19	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½ %	4 %	4 %	2½— 3	2¾ 3¼	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	...	8½— 9	8¾— 9¼	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½ % §	3½ % §	...	9 — 9½	9¼— 9¾	9⅝	9½
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½ % §	6½ % §	...	14⅞— 15⅛	14⅞— 15⅛	15⅛	14⅞
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	16 — 16½	16 — 16½	16¼	16
105,900£	Do. 5 % Debs., repay. August, 1899	100	...	...	...	107 —110	107 —110	...	...
1,294,100£	Do. 4 % Mort. Deb.	Stock	...	...	...	114 —117	115 —118	116	115½
250,000	Eastern Extension, Australasia and China Teleg., Ltd.	10	7 %	7 %	7 %	15⅝— 15⅞	15⅝— 15⅝	15⅝	15⅝
62,700£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	103 —106	103 —106	...	...
222,800£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	103 —106	103 —106	...	...
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	113 —116	114 —117	115⅝	115⅝
95,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —106	103 —106	...	...
129,100£	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	103 —106	103 —106	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	104 —107	104 —107	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	107 —110%	105 —108%xd	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	5½ % §	4⅞ % §	4⅝ % §	8⅝— 9	8⅝— 9	9	8⅞
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15⅛— 15⅝	15⅛— 15⅝	15⅝	15⅛
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜ % §	8⅜ % §	8 3/10 %	21⅜— 22¼	21¼— 21⅜xd	21¼	21⅛
200,000£	Do. do. do. 5 % Debs.	100	...	...	...	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	45 — 47	45 — 47	46½	46¼
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	4 — 6	4 — 6	...	...
100,000£	Do. do. 6 % Debs.	100	...	...	...	106 —109	106 —109	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	½— 1½	½— 1½	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1 — 2	1 — 2	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4⅜— 4⅞	4⅜— 5	4⅞	4⅜
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	15 — 16	15 — 16	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	14½— 15½	14½— 15½	14 11/16	14¼
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5⅜— 5⅝	5⅜— 5⅝	5 15/16	5⅜
925,017£	Do. 4½ % Deb. Stock Prov. Certs.	...	...	...	...	116 —118	115 —117	115 1/16	115
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	⅜— ½	⅜— ½	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	102 —105	102 —105	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	5½— 6½	5½— 6½	6¼	...
3,381	Submarine Cables Trust	Cert.	...	...	...	111 —116	111 —116	...	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1½— 2	1½— 2	...	...
146,370£	Do. do. 5 % Debs.	Stock	...	...	...	90 —100	90 —100	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	...	3 — 5	3 — 5	...	...
249,900£	Do. do. do. 5 % Debs.	100	...	...	...	100 —103	100 —103	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2½— 3	2½— 3	2⅝	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	103 —107	105 —109	...	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	...	7¼— 7⅜	7¼— 7⅜	7⅜	7 1/16
33,129	Do. do. do. 5 % Cum. Pref.	7½	...	...	...	6 — 6½	6 — 6½	...	...
33,129	Do. do. do. 5 % Def.	7½	3 %	...	...	2 — 2½	2 — 2½	2	...
178,200£	Do. do. do. 6 % Debs. "A," 1910	100	...	...	...	106 —109	106 —109	...	...
222,700£	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	106 —109	106 —109	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	...	1½— 1¾	1½— 1½	...	...
34,563	Do. do. do. 6 % 1st Pref.	10	...	...	...	10¼— 10⅜	10½— 11	10⅝	...
4,669	Do. do. do. 6 % 2nd Pref.	10	...	...	..	9 — 10	9 — 10	...	...
80,000£	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	108 —111	109 —112	110	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds	$1000	...	...	...	113 —118	110 —115 xd	...	...
169,000£	Do. do. 6 % Ster. Bonds.	100	...	...	...	100 —104	100 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

20,510	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½%	4 — 5	4 — 5	...	...
40,000	Cityof London Elec. Lightg. Co., Ltd., Ord. 40,000—180,000	10	...	...	...	12 — 13	12 — 13	12¼	12 3/16
20,000	Do. do. 6 % Cum. Pref., 1 to 20,000	10	...	6 %	6 %	13¼— 13⅜	13¼— 13⅜	13¼	...
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) £75 paid	...	...	...	...	... ...	82 — 85	84¾	...
19,900	*Electy. Supply Co. of Spain, 101 to 20,000	5	...	...	...	... ...	... ...	...	...
5,523	†Liverpool Electric Supply, £4 10s. paid	5	....	...	...	5⅞— 6⅛	5⅞— 6⅛	...	...
39,477	Do. do.	5	4½%	5 %	5 %	6⅛— 6⅜	6⅛— 6⅜	6⅛	...
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000	10	1 %	2 %	...	7⅛— 7⅜	7 — 7⅛xd	7 1/16	7⅛
100,000£	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	106 —109	106 —109	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4⅛— 5⅛	4⅛— 5⅛	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7¼%	4½%	6⅝— 7⅛	6⅝— 7⅛	7	6 15/16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 8⅛	8 — 8⅛	8⅛	8 1/16
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000	5	...	3½%	4 %	5⅞— 6⅛	5⅞— 6⅛	6 1/16	6

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ¶ Dividends paid in deferred share warrants, profits being used as capital

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, April 25th.	Closing Quotation, May 2nd.	Business done during week ended May 2nd, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2⅞ — 3	2⅞ — 3	2⅞	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2⅛ — 2⅜	2⅛ — 2⅜	...	...
125,000*l*	Do. do. 4½ % Deb.	Stock	...	...	...	108 —111	108 —111	108¾	...
630,000*l*	City and South London Railway	Stock	...	⅝%	⅝%	27 — 32	27 — 32	28	...
20,000	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 20,000	5	7 % §	7 % §	7 % §	3½ — 3⅝	3½ — 3⅝	...	...
50,000*l*	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	95 —100	95 —100	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	½ — 1	½ — 1	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1½ — 1⅝	1½ — 1⅝	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd., 1 to 66,750 ...	2	*nil*	*nil*	*nil*	¼ — ⅜	¼ — ⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	½ — ¾	½ — ¾	...	...
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	½ — ¾	½ — ¾	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½ — 1½	½ — 1½	...	...
12,134*l*	Greenwood & Batley, Ltd., Ord., 4,667 to 16,800	10	...	...	...	4½ — 5½	4½ — 5½	...	...
9,600*l*	Do. do 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½ — 7½	6½ — 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	...	...	...	—	6 — 7	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	23 — 24	23 — 24	23⅝	23
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	101 —103	102 —104	...	...
11,334	International Okonite, Ltd., Ord., 22,667 to 34,000 ...	10	5 % §	...	...	1 — 2	1 — 2	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	7 — 7¼	7¼ — 7⅜	7½	...
6,295	† Do. do. Pref., £8 paid	10	...	...	...	12⅜ — 13¼	12⅜ — 13¼	13	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 % §	10 % §	7½% §	2 — 2½	2 — 2½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	39 — 41	39 — 41	39¼	...
150,000*l*	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	... ...	... ...	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¼—5⅜.

Electric Construction Corporation, 6 % Debentures, 87—92.

Electric and General Investment, shares of £5 (£1 paid), 1⅞—2¼.

Electricity Supply Corporation, Ordinary of £5, 5—5¼.

House-to-House Company (£5 paid), 1—1½.

Do. do. 7 % Preference, of £5, 5¼—5½.

Do. do. 6 % Debentures of £100, 101—103.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅞—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅜.

Liverpool Electric Supply, £5 (fully paid), 6½—6¾.

Do. do. £3 10s. paid, 4½—4⅝.

London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.

Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4¾.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

REFUSE DESTRUCTORS AND THE GENERATION OF STEAM.

The report of the Hull Joint Sanitary, Works, and Electric Lighting Committee on refuse destructors, and steam generation and electric tramcar working therefrom, has been printed, and was presented at the meeting of the Electric Lighting Committee, held at the Town Hall last week, when it was ordered to be entered on the minutes. The report states:—

The Council having recently had intimated to it:—

"1. From the Sanitary Committee—That more destructor cells would soon be needed to meet the increasingly large amount of town refuse sent in, and that it might be necessary to put such cells in different parts of our quickly-spreading town.

"2. From the Works Committee—That in any arrangement for buying and leasing the town's tramways, it would be desirable to arrange that electricity, when needed, should be taken from the Corporation supply; and

"3. From the Electric Light Committee—That the establishment of electric lighting stations and electric tram traction, or accumulator cell supply, might be more expeditiously and economically worked in outlying districts if the steam generated from town refuse destructor could be utilised at destructor stations;

"The Council resolved that a committee, consisting of two members from each of the above committees, should be appointed to investigate and report on (*a*) the feasibility of using the heat at present obtained from burning refuse for generating steam for useful and profitable purposes; (*b*) to investigate the results at the different places where these cells were working to profit instead of cost; (*c*) to report on the best kind of cells in use, and to what industry their steam is being employed; and (*d*) especially to observe the kind of electric work to which it might be made available.

"The committee thus formed, on investigation, found that the opinions of engineers and experts as to the best methods of obtaining heat from destructors were as diverse as was the number of stations; that no station had yet suggested its application to electric cell charging, and that the ideas of its utilisation were unsettled and vague; it therefore became necessary to judge the systems on the works of typical stations, where steam has been applied to various useful and profitable purposes . . . . . The first visit was made to Leeds and Halifax, where the wisdom of personal investigation was thoroughly established. At these places the committee learnt two things, either of which should amply repay the Corporation for any expense attached to this inquiry, namely:—

"First at Leeds: The deputation were informed that steam sufficient to produce about 250 horse-power could be obtained from the ten cells at the Kidacre Street destructor, which was burning about 70 tons of refuse per day, and from the observations taken, and the machinery seen in actual operation, it is probable these statements were fully justified. It was generally agreed that with a different arrangement of cells and boilers, more steam could be continuously generated from the same heat, and that for years past Hull had been running to waste a product worth a considerable sum. Second at Halifax: That the much extolled 'Livet's' system, pronounced by some engineers and experts as being the best system extant, and so described in illustrated and other papers, was a system that the deputation cannot recommend for adoption in Hull. If it were adopted many thousands of pounds would probably be wasted.

"At Leeds, the deputation saw the results of a test extending over several days and nights, during which the temperature in the flues never went below 1,500 degrees. The steam from the boilers produced by this heat was used to drive an engine working a mortar mill, the mortar from which was sold to the builders of the town. They were not half utilising the steam they could generate, and were thinking of lighting the Municipal Buildings electrically from their spare heat. We learnt here how and where they disposed of their old tins (which at our Chapman Street destructor are a great nuisance and cost) at a profit; and at Southampton we received a hint for another useful purpose for these tins. Many useful details were obtained which cannot but be helpful in various committees. The committee next visited Birmingham, and the practical things here learnt were, that at both their yards refuse was capable of generating steam; that we ought to avoid working and baking night-soil, as the process befouls the air; that the engines driven by the steam obtained as mentioned were working mills making mortar, which they use in erecting public buildings; that the mortar is made from the clinkers got out of the furnaces, and that the mortar is good and durable; and that besides this they have with advantage made concrete of the clinkers for various purposes, and so hard as to stand being polished.

"At Leeds the destructor cells were worked by forced draught created by steam jets. At Birmingham both steam jets and fans were used for causing the forced draught, and although the opinion was there expressed that the fan was preferable to the steam jet, yet a greater heat appeared to be obtained with the steam jet at Leeds than with the fan at Birmingham. The view of the committee is that the destructors at Leeds are very much to be preferred to those at Birmingham as regards their general efficiency and steaming powers.

"On the same day the committee went to inspect the system of working trams by electric accumulator cells. The system, although practical at a cost, is not a financial success, though they charge 1d. per mile per passenger. The line over which it runs in Birmingham is in no way comparable with that in Hull, for it runs through a comparatively country district, which possibly might be best compared with that from Carr Lane to Anlaby, with few houses and many fields for the greater part of its run. The prolonged and steep gradients in Birmingham destroy the life of cells at a frightful rate; and our level roads in Hull offer chances to the efficiency and life of cells that would bring such a system into a favourable chance of economically replacing horse user. If we could use refuse to obtain steam for working an electric dynamo, that system would present a good opportunity of obtaining electricity for charging cells at a very much more economical cost than that used in Birmingham; and such system could be well charged at a tram station worked in combination with refuse destructor works. . . . . In Hull our cars can easily contain cells carrying all the power necessary. The inclines being entirely absent, the charge in the cells will thereby not be called upon to this point of exhaustion, the life of the plates will be prolonged, they will run much longer journeys without recharging; the station engines will not be required to run so often to charge the cells; the cars and their attendants will not lose time in having to come to the station for recharging, and the life of the cells themselves will be much prolonged. Hence there is money to be saved in each of these items as well as that which might be got from refuse destructor steam. This must, in our opinion, tend to make an electric car running in Hull a profit where it is just a margin over the wrong side in Birmingham. We are not here recommending its adoption, because we had already heard of some chloride cells of half the size, of much longer life, half the weight, and higher power, being used in Paris, and it will be well to know more of these chloride cells. At Birmingham, Mr. Manville inferred that his firm were likely to test them, and, if they proved half what he said, an economical revolution in electric accumulator cell trams would be effected.

"We make no recommendation on this point, for other reasons, which are that (*a*) we are not called upon at present to work electrical cars, and (*b*) that at our next visit we saw a different user of electrical traction, which is equally, if not more, economical and practical, if the Corporation can get over its objection to seeing electrical overhead lines running down one side of the street.

". . . . . Our next inspection was of the overhead electric tramway system at Walsall. The poles carrying the overhead wires are on one side of the road only, entirely different from the Leeds system. Some of these poles might be arranged to carry electric street or gas lamps. The trams run with ease and simplicity, they are completely under control by a lever to start or stop, they run either way by the simplest arrangements, and they go up and down inclines much steeper than any in Hull (even Park Street Bridge) with ease and celerity. They run as easily in narrow as wide streets.

"The tramcars are fed from a station whose electric supply and engines work with extreme regularity, and very few hands are employed. The load on the station varies as much, when twelve cars are running, as from 300 to 20 horse-power in fifteen seconds, just as the cars stop, or start, and are running; yet, under this variety of call for power, there is not the slightest difficulty in working. The engines run with smoothness and ease, the electric dynamos regulating themselves easily to the call. We were told the cost could be reckoned at 4½d. per car mile, and that the system (exclusive of permanent way) can be erected at about £600 per mile.

"At our visit to Southampton our attention was chiefly directed to the refuse destructor and its work. As to the destruction of refuse at this town, it is used to make steam which works an engine for a sewage pumping station. Before they made steam the destructor cost them over £200 a year without any return, but now that they have an engine and boiler they not only work their own sewage pump but sell for a charge of £200 to the township of Shirley, outside the borough, power obtained from the destructor to raise its sewage by pumping; also, beyond this, they make mortar from the clinkers which they crush by mortar mill, and make flags of crushed clinkers, faced with broken crockery out of the refuse. These flags are hard and serviceable, and we were shown some laid down in the street in the jubilee year, which were as good and suitable a pavement as one might wish to see. Beyond this, their steam engine worked chaff cutters, and a winnowing machine for their stable uses, and the stables, &c., had been built from the mortar made from the refuse clinkers. They had also built for the corporation some magnificent Turkish baths, containing ladies' and gentlemen's swimming baths of magnificent proportions, whilst outside was an open-air circular bath, lit at night with electric light, in which as many as 300 bathers had been assembled at night.

"At Ealing we went to see the adaptation of an electric light station as served by steam from refuse destructor cells. The station is only yet in the course of construction. The refuse burnt is entirely different to that at any other place which we visited, as sewage sludge from the sewage precipitation tanks, which are close by, is mixed with it before it is burnt. The steam from the burning of the refuse here, as at other places, works mills in which clinkers are crushed for mortar, and the mortar is being used in the erection of the electric light buildings. Flags, window and door heads and sills, are also made from the clinkers.

"The recommendations of the committee are:—

"1. That a boiler or boilers, as required, be obtained and built into the flue of the present destructor in Chapman Street.

"2. That steam jets be thence taken (as at Leeds) under the Chapman Street furnaces.

"3. That a small engine be first tried, so that

"4. A mortar mill to make mortar and crush the clinkers for the making of concrete flags, as at Southampton, be obtained and tried.

"5. That for reasons previously stated, the committee at present do not recommend the Council to put down a plant for the charging of accumulator cells, but the progress and development of the different accumulator and other systems will be watched, and when opportunity offers it is the intention of the committee to submit a further report to the Council.

"The mortar and flags could be used on our own works, and the engine power could be increased as found desirable. The experience gained by the use of the foregoing plant would assist the Corporation in forming an opinion as to the best means of afterwards extending it."

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

COST OF ELECTRICAL ENERGY. By R. E. CROMPTON, M.Inst.C.E., Vice-President. (Read Thursday, April 26th, 1894.)

(*Continued from page* 501.)

In addition to the accounts of the 23 works examined, I have also examined the accounts of 10 foreign works; but I find their information is too incomplete and too difficult to bring to a basis of comparison with our English works, and I do not complicate my table by adding them in.

Of the 23 English works examined, 10—viz., those at Bournemouth, Chelmsford, City of London, Eastbourne, House-to-House (London), Metropolitan, Newcastle and District, Newcastle-on-Tyne, Leeds, and Exeter—distribute the bulk of their output on the converted alternating system. Two works—viz., those at Chelsea and Oxford—distribute on the converted continuous system. Eleven works—viz., Birmingham, Bradford, Brighton, Charing Cross and Strand, Hove, Kensington, Knightsbridge, Liverpool, Preston, St. James's and Pall Mall, and Westminster—distribute on the direct system.

In Table VI. I have grouped these 23 works into these three

TABLE VI.—COMPARISON OF FUEL USED.

Works.	Distinguishing letter.	Cost of fuel per unit sold.	B.T.U. in fuel used per watt-hour.	Efficiency of distribution.	B.T.U. per watt-hour generated.	Description of plant.
CONVERTED ALTERNATING SYSTEM.				per ct.		
Newcastle and District	A	0·8	310	70	218	Steam turbine.
Leeds	B	1·23	300	66	200	Alternators, rope driven.
Bournemouth ..	C	1·81	232	69	160	" "
House-to-House ..	D	1·93	265	66	175	" "
Newcastle-on-Tyne	E	0·64	262	66	173	" "
Metropolitan ..	F	1·8	232	66	153	" " (1892) Mixed system.
Eastbourne	G	1·42	180	60·8	109	Alternators, rope-driven.
Exeter	H	1·35	135	66	89	" "
Average of B, C,	D, E, & F		245	—	161	" "
MIXED SYSTEM.						
City of London ..	I	1·24	172	82	141	Mixed system, driving.
Chelmsford	J	0·96	146	76	112	" "
Average of I & J	—	—	159	—	126	
CONVERTED CONTINUOUS.						
Chelsea	K	1·11	142	62	88	Dynamos, driven direct.
Oxford	L	0·70	88·5	62	55	" rope-driven.
Average of K & L	—	—	115	—	72	
DIRECT SYSTEM.						
Preston	M	1·65	315	80	255	Dynamos, driven direct by double-acting engines.
Liverpool	N	0·95	186	75	143	Dynamos, driven direct by single-acting engines.
Birmingham ..	O	0·88	183	75	140	" "
Charing Cross and Strand	P	1·13	147	90	132	" "
Hove	Q	1·26	147	82	120	" "
St. James's and Pall Mall	R	0·95	126	90	114	" "
Bradford	S	0·66	119	88·7	110	" "
Brighton	T	0·904	117	80	94	" "
Kensington	U	0·87	116	86·5	100	" "
Westminster ..	V	0·78	104	88	92	" "
Knightsbridge ..	W	0·632	84	91·5	78	" "
Average of N to W	—	—	133	—	112	
Ideal Works ..	—	0·27	36·25	90	32·6	

systems of distribution, and have arranged them in each group in order, always heading the list by the works that uses the largest quantity of fuel. It is curious to remark that this system of grouping also divides them very fairly into the two great divisions of

1. Rope or belt-driven plant.
2. Direct-driven plant.

In the first group I have averaged the fuel consumption in T.U. per watt-hour, omitting from the average the first-named works, as the conditions of working are somewhat abnormal; and, similarly, in the last group I have averaged the fuel consumption for the whole, with the sole exception of the first-named works—*i.e.*, Preston—the

conditions in this case being also abnormal. These averages show that the consumption of fuel per unit sold in the first group is about 94 per cent. greater than in the direct group; but as this difference is made up very considerably by the difference in efficiency of distribution, I have calculated the actual fuel consumption at the terminals of the dynamo by the efficiency of distribution of the two systems, which I regret to say is in several cases an assumed figure, as in several cases it appears to be actually unknown to the works' engineers themselves.

The table shows that, whereas the efficiency of distribution of the converted alternating systems is apparently somewhat under 66 per cent., with the direct systems (excluding the two-wire systems) it is about 86 per cent. The fuel used per unit generated in the converted alternating systems appears to be 43 per cent. higher than that used by the direct systems. In making these calculations, I have carefully avoided considering those where a mixed system of distribution is used. The table also shows that the fuel average of the works where the alternators or dynamos are rope-driven is about 46 per cent. higher than where the dynamos are direct-driven by high speed engines, and I think that the information that the table gives on this point is of the utmost importance, as it shows in a marked degree the economical advantages of high speed direct-driven steam dynamos over slow speed engines driving dynamos or alternators by ropes or belts.

I should here state that the preparation of Table VI. has been the principal cause why this paper has been delayed to such a late period of the session. The figures, as printed in the proofs that you have in your hands, have been altered several times, as additional information has been forwarded to me by the various engineers in charge. Even now I find that several mistakes and omissions exist. Some of them have been corrected on the large Table on the wall, but those in your hand need correction as follows:—

The averages of the first group include all the works mentioned, with the exception of the Metropolitan and Exeter; the Metropolitan being for the year 1892, and the Exeter accounts being based on an estimated and not actually measured output.

Again, the efficiency of distribution of the Chelsea Company, hence the calculation per unit generated ought to have been omitted. The figure given is that that would be obtained if the efficiency of distribution was the same as at Oxford. The Oxford figures came in at such a late period that I was unable to mention them in the body of the paper. The results are very encouraging; in fact, I think they are too good to be true, especially when we come to consider the corresponding use of stores in Table VII. I have received a communication from Mr. Hunter, representing the Newcastle and District Company, in which he begs that I will make it clear that of the steam turbines used during the past year, only one was condensing; he also demurs to the figures I have given of 310 B.T.U. per watt, as he says the calorific value of the coal used at Newcastle was only 7,250, instead of 11,300, the figures assumed by me.

In explanation of my calculations, I may say that I used the figure 11,300 as furnished to me by Mr. Jackson, of the Newcastle-on-Tyne Company; but I believe that even this figure is too low, and that good Newcastle slack, such as any commercial man would purchase for steam raising purposes at Newcastle, has a value not less than 13,000. I use identically the same slack for my Chelmsford works, and pay for it a price that is not higher than is now paid by either of the Newcastle companies, and I find on actual test that it has a calorific value of 14,000, so that I cannot accept Mr. Hunter's explanation that the high fuel consumption at Newcastle is due to the inferior quality of the coal used.

I have also received a communication from the St. James's and Pall Mall Company, altering the figures given in Table VI., which were the 1892 figures; the alteration is, however, entered on the Table on the wall. I must also say that I have not made any selection in the accounts entered in this table. I have taken all the accounts that were ready at the time I prepared the table, and those that are omitted were omitted solely at the request of the engineers in charge, on the grounds that the only figures available, of 1892, did not represent the present state of affairs.

Eight years ago I stood almost alone when I recommended that the 1,200-H.P. load of the Vienna central station should be divided amongst eight steam dynamos, coupled direct to high speed engines, as at that time most engineers still believed that high economy in the use of steam could only be obtained by putting down long-stroke slow speed engines, such as are commonly used in cotton mills, and driving from these engines the dynamos by means of ropes or belts. This superstition was founded on the belief that steam could only be economically used in large engines of this type, which obtained their high piston speed by long strokes and few revolutions per minute; but it did not take long to show that the great variations of load in an electric supply works causes these huge engines to run for many hours at a very small fraction of their load, making them very uneconomical, so that the subdivision of their load between several smaller engines became necessary.

Mr. Willans, in his first and historic paper on steam engine economy, read before the Institution of Civil Engineers, was the first to strike a blow at the erroneous belief that economy could only be obtained from long-stroke slowly revolving engines, by showing that as the enemy to economy, particularly in the smaller engines, is cylinder condensation, the true way to reduce this is not by mere piston speed, as was the current belief, but by reducing the time during which the cylinder surfaces are exposed to the cooling action of the exhaust or of the condenser previous to each fresh steam admission—in other words, by using rapidly revolving short stroke engines instead of slowly revolving long stroke ones. Once this was understood, it followed that the high speed engine making many revolutions, and therefore best suited for coupling direct to our dynamos, is also theoretically the most economical in use of steam. That this is also true in practice is shown by the long series of experiments carried out by Mr. Willans, and the figures that I am now putting before you. The advantages of direct driving are obviously not confined to the Willans, or, indeed, to any single-acting type of engine; in fact, we have now a considerable choice of high speed engines, all of which can be coupled direct to dynamos, and which use their steam economically. There is one advantage common to all direct-driven steam dynamos, *i.e.*, their high efficiency in $\frac{\text{E.H.P.}}{\text{I.H.P.}}$. This efficiency, which has been gradually creeping up from 80 per cent., which was the efficiency we obtained from the Vienna steam dynamos in 1886, to the very high figure of 88 per cent., which has recently been obtained by a Willans-Siemens combination, has been much commented upon, and has, in some quarters, met with actual disbelief; but all who know how accurately the tests have been carried out at Thames Ditton, and who have themselves made independent check tests, know also that such an efficiency can be obtained without difficulty—in fact, that efficiencies in excess of 86 per cent. can now be guaranteed at full loads, and 80 per cent. at half loads.

The case is far different with rope or belt-driven sets. In most cases it is difficult to obtain an efficiency of 78 per cent. at full load, and 70 per cent. at half load when the engines are fitted with the ordinary unbalanced slide valve, or 80 per cent. at full load and 73 per cent. at half load when the engines have Corliss or balance valves. I must, however, note that Mr. Parker, in his paper, read before the Institution of Civil Engineers, on the Liverpool Overhead Railway, gives us the satisfactory results obtained from slow running horizontal engines driving dynamos by ropes; but, although I do not challenge Mr. Parker's ultimate figures, yet I think that without doubt he has made a mistake in his calculated efficiency—that is to say, $\frac{\text{E.H.P.}}{\text{I.H.P.}}$. I think that it would be difficult for me—or, in fact, for anyone who has paid much attention to the losses due to the friction of steam engines, and particularly of condensing engines, and to losses occasioned by rope driving—to accept Mr. Parker's figures. No one has made more careful experiments on the friction of such engines than Messrs. Sulzer, of Winterthur, and Messrs. Carels Frère, of Ghent, who make the same type of engines. I have been informed by the latter that an engine efficiency of 91 per cent. is only rarely obtained; generally the efficiency is somewhat lower. Mr. Parker states that the electrical efficiency of his dynamos is 97·7 per cent., which is an extremely high figure. If we take the commercial dynamo efficiency at 96 per cent., which is an outside figure when we consider the side strains on the bearings caused by the rope driving, and if we suppose that the loss due to the rope driving is only 2 per cent., which I believe is less than has ever been noticed, it is just possible, with a 91 per cent. engine, a 2 per cent. rope loss, and a 96 per cent. dynamo, to get 85·6 per cent. efficiency.

Although I do not believe that such an efficiency, and correspondingly small consumption of steam per E.H.P. at full and half loads, can be obtained in practice by engines driving dynamos by ropes, yet it is so often attained by direct-driven sets that at least one maker can now guarantee figures very closely approaching the ideal figures I have given of 18½ lbs. of steam per unit at full load and 21½ lbs. at half load. Yet in the cases of direct driving such high efficiency is easily accounted for. In the first place, the engines are fitted with piston valves, which are the most perfect form of balanced valves; hence the internal friction of the Willans or Chandler engines, running as they do with all their parts thoroughly bathed in oil, must be probably lower than that of any other type of engine. Moreover, with direct driving, there is no side strain whatever on the dynamo bearings; and even the downward pressure on these bearings can be partially eased by so placing the armature core in relation to the bore of the magnets that a certain amount of lift is given to the core at the time that the magnets are excited. Under such conditions it will be seen that the engine and dynamo mechanical friction can be reduced to a minimum—in fact, to a point very far below what is possible when any form of rope or belt driving is used. The figures that I now give show that the best results yet obtained have been with Willans engines driving direct-current dynamos; and I believe this is mainly due to the great reduction of friction which I have just mentioned, and which tells heavily in favour of this class of steam dynamo when it is only partially loaded. Hence we find that, whereas the combined efficiency of a Willans combination is as high as 80 per cent. at outputs as low as two-thirds full load, the combined efficiency at two-thirds load of a slide-valve engine driving a dynamo by belts or ropes rarely exceeds 70 per cent.; and unfortunately, however much we may desire to keep the load factor of the engine above 66 per cent., or two-thirds, yet under existing circumstances it is a matter of difficulty to do so even in works where accumulators are used, and in works where there are no accumulators with all converted systems the average engine load factor appears to be far below this.

As you no doubt expect me to express an opinion as to the cause of the wide differences in economies of fuel shown in these comparative tables, I must point out that even, if we exclude the difference in distribution efficiency by making the allowances that I have done, there still remains three sources of loss—one already dealt with under the heading of the boilers, and the second due to the engines, dynamos, or alternators, and the third to losses which have been called by Kennedy "obscure works losses." Now, I think the main cause of the difference in engine and dynamo losses lies in the fact that in the works under consideration the engines have been driven at widely differing load factors; and, as whenever the engine load factor is low the use of steam is correspondingly high, I think that this question of engine load factor is of supreme importance. As I have shown above, a low engine load factor tells more against belt or rope driving sets than against direct-driving ones; but in neither case has the subject received the attention that it deserves. Every

facility should be given for the men in charge of the steam dynamos to ascertain for themselves at any time at what load factor they are driving their plant, and if this were done more frequently I am sure that great improvements would result. One reason why at present the men in the supply stations know so little about this question is, that in most cases it is only looked into as a sort of holy mystery by the engineering staff, and at long intervals of time; whereas I feel strongly a book ought to be kept in every works, and the men in charge should always enter up the load factor of each engine during the hours the stop valve is open; and in order that this may be done with a minimum of labour, I have devised and used in our Chelmsford works a system which I will here describe for the benefit of those who care to adopt it.

A diagram was shown which had its base line marked off in percentages of the load of the engine; and the same line is, in addition, marked with the steam chest pressures, corresponding to these different percentages of load. This steam chest pressure can be noted by a carefully calibrated gauge fixed on the steam chest of the engine, the calibration being carried out as each set of indicator diagrams and electric load readings are taken; the result being that the man in charge of the engine can see at a glance from these steam gauges what ought to be the indicated and corresponding E.H.P. that his engine is giving, and from the same diagram he is able to calculate the consumption of pounds of steam per hour.

Opposite to each gauge pressure is entered the theoretical consumption of steam per horse-power per hour at the standard speed, ascertained from Mr. Willans's table. Thus, if the man in charge enters up these steam pressures of all the running engines every quarter of an hour, it is easy to prepare an accurate report on the engine load factor of the day, and thus compare the calculated with the actual steam used during the run; so that men who habitually underwork their engines can be thus noted and reprimanded.

Of course, I know from experience how much more difficult it is to work engines driving alternators at a high load factor than is the case with continuous current steam dynamos. This is partly caused by the comparative difficulty and complication involved in paralleling alternators, compared with the ease of throwing continuous dynamos in and out of parallel on a storage system. In the latter case the enginemen have only one order to observe, viz., to keep their engines as fully loaded as possible on a rising load, not to start an additional set until the sets previously running are considerably overloaded, and on a falling load to shut down the sets at the earliest possible moment, even if it leaves the remaining sets somewhat overloaded for some time. Unless such orders are given and carried out to the letter, so that engine load factors exceeding 70 per cent. on the average are obtained, it is useless to expect to reduce the consumption of steam below 50 lbs. per unit generated.

The other causes of waste of steam in electric supply works are those which Prof. Kennedy, in his lecture at the Royal Institution, speaks of as "losses about which we engineers feel very sore, and which sometimes try our temper and our patience greatly, and are not recognised as having any kind of respectable existence." These are those connected with leaks from boiler fittings and steam pipes, with condensation losses in the steam pipes, and due to the wasteful use of steam by all present known means of boiler feed.

These losses have been ignored by engineers, and have never received the attention they deserve; but, as they continue throughout the twenty-four hours, they amount to a very considerable percentage of the steam evaporated by the boilers, and of course tell most during the summer months, or, in fact in any works where the load factor is low. Engineers who have been most successful in dealing with these difficulties, and have minimised these losses to the greatest extent, are those who previous to entering electrical works have received a practical engine room training, either as sea-going engineers, or in engine rooms of a similar class where fuel economy has been persistently studied. I believe the best remedy for the pipe condensation losses will lie in the direction of superheating the steam after it leaves the boilers. If we could superheat the steam so as not only to have no pipe condensation at all, but to deliver the steam to the engine cylinders at a temperature 8 or 10 per cent. above the corresponding temperature for saturated steam, I believe that we should at once save nearly 10 per cent. of the steam that we now have to evaporate in our boilers. It is very easy to talk of superheating steam. In the days of low pressure steam at 15 lbs. pressure such superheating was a reasonably easy matter; but the case is widely different when the high pressure steam leaves the boiler at a temperature of 375°, as is now the case. Any further superheating is very much in the nature of passing this steam through pipes at a temperature which nearly amounts to red heat, so that it is little wonder that not many engineers have cared about tackling such a difficult and risky problem; but it is quite certain that this problem will be tackled, and I have recently heard that it has been satisfactorily dealt with by Messrs. McPhail & Simpson, the superheater consisting of a large number of bent tubes made of thick lap-welded iron, each tube being only about 1 inch diameter. The bent portions of these tubes are so placed that they are exposed to the hot gases when they first pass through the flues of the boiler, such as the space at the end of a Lancashire or of an "Economic" boiler; in the case of the Babcock boiler it would be more difficult to find a place for them. It is evident that whoever attempts to deal with this problem of working out a satisfactory superheater will have a great many difficulties to deal with. The superheater must, as I have said, be placed so as to be exposed to the high temperature gases, and yet it must be accessible for ready replacing of the tubes and for repairs. Moreover, it must be easily put in and out of circuit, so that a failure of one of the tubes should not in any way cripple the steam supply of the works. These requirements are in a sense contradictory, but I have no doubt, now so many minds are directed to this problem, it will be successfully dealt with.

(To be continued.)

NEW PATENTS—1894.

7,510. "Improvements in machines for recording telegraph signals given to persons in control of steam engines." J. S. D. Shanks. Dated April 16th.

7,530. "An improvement in electrical glow lamps." The Edison and Swan United Electric Light Company, Limited, and J. M. Moffat. Dated April 16th.

7,538. "Improvements in oil engines." J. Roots. Dated April 16th.

7,539. "Improvements in lifting, crane, and hoisting apparatus operated by electrical energy." G. L. Davies. Dated April 16th.

7,595. "Improved means for economising fuel and consuming smoke in steam boiler and other furnaces." W. Heywood. Dated April 17th.

7,603. "Application of electricity to the manufacture of cyanides and ferrocyanides and improvement in same. Preservation of vessels from corrosion." C. J. Hammerton. Dated April 17th.

7,607. "Improvements in arc lamps." W. Defries and V. I. Feeny. Dated April 17th.

7,617. "Improvements in thermo-electric generators." H. B. Cox. Dated April 17th. *(Complete.)*

7,630. "Improvements in means for operating and controlling the valves of steam, gas, or oil engines." F. H. Butter. Dated April 17th.

7,645. "Improvements in underground conduits for electric railways." J. B. Brand and C. L. Franklyn. Dated April 17th. *(Complete.)*

7,684. "Improvements in or in connection with electricity meters." W. L. Spence. Dated April 18th.

7,688. "Improvements in or in connection with electricity meters." G. Hookham and S. H. Holden. Dated April 18th.

7,691. "Improvemehts in the manufacture of carbon rods for electric arc lights." C. A. Muller. (Communicated by C. Schmelzer, Germany.) Dated April 18th.

7,700. "Improvements in electric light ceiling roses." J. D. F. Andrews. Dated April 18th.

7,711. "An improved arrangement of element board for electro-diagnosis." W. J. Bishop. Dated April 18th.

7,716. "Improvements in gas engines." C. Vallet. Dated April 18th.

7,718. "Improvements relating to mains for alternate current installations." G. G. M. Hardingham. (Communicated by Felten and Guilleaume, Germany.) Dated April 18th.

7,758. "Improvements in induction electrical machines." F. Tudsbury. Dated April 19th.

7,794. "Improvements in steam boilers." T. Herald. Dated April 19th.

7,801. "Improvements in or relating to electrolytical apparatus." C. Kellner. Dated April 19th.

7,815. "Improved means for effecting the lighting of velocipedes by electricity." T. J. Tomlinson, Jun., and O. Robson. Dated April 20th.

7,853. "An improvement in the electro-deposition of heavy metals with a base metal alloy." W. A. Thoms and W. H. Burgum. Dated April 20th.

7,854. "An improvement in the coating of metals with a metallic alloy." W. A. Thoms and W. H. Burgum. Dated April 20th.

7,865. "Improvements in the construction and working of galvanic batteries." D. G. FitzGerald, and A. W. Southey. Dated April 20th.

7,875. "A galvanic chain for curative purposes." F. Fritsche. Dated April 20th. *(Complete.)*

7,879. "Improvements in and relating to reflectors for electric arc lamps." C. Coerper. Dated April 20th. *(Complete.)*

7,905. "An improved shunt arc lamp." R. J. Canavan. Dated April 21st.

7,933. "Portable apparatus for heating by electricity water, milk, or other liquids contained in cups, jugs or other vessels, and for making tea and other drinks." W. Corin. Dated April 21st.

7,935. "Improvements in electric telegraphy." K. O. A. Gulstad. Dated April 21st.

7,950. "Improvements in apparatus for electrolytical purposes." H. Guthrie. Dated April 21st.

7,955. "Improvements relating to electric measuring instruments." J. H. Thomson. Dated April 21st.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1892.

23,101. "Improvements in and connected with galvanic batteries." C. A. J. H. Schroeder and H. E. R. Schroeder. Dated December 15th. Consists chiefly in employing instead of single amalgamated thick zinc plates or sheets plates which are composed of a number of thin amalgamated zinc plates which are pressed together by any suitable device, thus forming a thick plate; or by employing as positive electrode plates of magnesium, or plates of an alloy containing:—From 50 to 99 parts by weight of zinc; from 0·04 to 12 parts by

weight of lead; from 0·001 to 6 parts by weight of aluminium; from 0 to 1 part by weight of any suitable barium compound; from 0 to 2 parts by weight of manganese; from 0 to 2 parts by weight of iron; from 0 to 18 parts by weight of mercury. 12 claims.

1893.

583. "Improvements in self-recording electric meters." A. Wright. Dated January 11th. Relates to a self-recording ammeter or voltmeter, consisting of a combination of a differential thermometer, heating coils, and recording indexes. 3 claims.

1,355. "Improved apparatus for forming electrothermal plates, tubes, conductors, and the like." Sir C. S. Forbes. Dated January 21st. Consists in special apparatus for rapidly producing such plates or tubes at one operation. 3 claims.

1,539. "Improvements in and connected with arc lamps." C. A. Pfluger. Dated January 24th. The lower carbon is preferably flat and held by set screws; the bottom of the lamp is a plate held in position by side bars having a projecting rim or rims into which is screwed spring rods slotted at their free ends to receive a surrounding ring; the globe is carried on a sliding support and is provided with a pocket to collect droppings from the carbons; in this way the globe may be moved up or down and secured by set screws. 4 claims.

2,010. "Improvements in electricity meters worked from a central position." W. H. Scott. Dated January 30th. Applies to electricity meters which integrate periodically the amount of current flowing and that are worked from a central position by means of special meter wires along which periodic currents are sent which either act direct on the main meter coils or work a relay which completes a shunt circuit or the like or which act as in this invention by means of a magnet or its equivalent which can move an arm or feeler connected to the integrating apparatus of the train of wheels every time the periodic current is sent, an amount in proportion to the current flowing; so that the integrating apparatus to which it is connected will move the train of wheels an amount in proportion to the current flowing. 4 claims.

3,772. "Insulating and preserving metal arms used for supporting electric telegraph insulators, and for kindred purposes." T. G. Marsh. Dated March 4th. Claim:—Enamelled metal arms, substantially as described, for supporting insulators and wires for electric telegraph and kindred purposes.

4,390. "Improvements in electric arc lamps." E. Cannevel. Dated February 28th. Claims:—1. In an electric arc lamp, controlling the feed of the carbons by means of clockwork with a tangent escapement, that is to say, an escapement oscillating in a plane at right angles to the plane of the escapement wheel, in combination with a friction brake on the escapement spindle controlled by the action of an electro-magnet on a shunt circuit of the lamp, substantially as described. 2. In combination with the tangent escapement and friction-brake mechanism referred to in the preceding claim a rocking frame carrying a pitch wheel over which passes a pitch chain to which the upper and lower carbon holders are attached, which frame operates in combination with an electro-magnet or solenoid on a shunt circuit in such manner that the passage of a current through the shunt circuit on the one hand causes the frame to be lowered so as to effect the approach of the carbons, and on the other hand releases the friction brake of the escapement so as to allow the pitch wheel to rotate, and consequently the upper carbon to descend, substantially as described.

4,691. "Improvements in the manufacture and production of elements for secondary batteries." The Lithanode and General Electric Company, Limited, and J. T. Niblett. Dated March 3rd. Consists in employing in the manufacture of lithanode, an inert material or salt which will afterwards be removed or dissolved out and will leave the element in the condition of porous lithanode presenting large surface to the electrolyte. A suitable salt for the purposes of this invention is sulphate of magnesia. 3 claims.

4,793. "Improvements in connection with portable electric bells." J. O. Brooke. Dated March 6th. Consists in the construction of a battery box in connection with portable electric bells with projecting sides all round the box, both before and behind, thereby forming a reel upon which to coil the flexible cord or wire, the projecting sides being intended to prevent the cord or wire from slipping off the reel, or becoming entangled when it is desired to coil the said cord or wire and at the same time to give an ornamental effect to the apparatus, the cord being practically hid from view. 1 claim.

6,605. "Improvements in materials for diaphragms for use in electrolytic processes, applicable also for filtering and other purposes." E. T. Parker. Dated March 29th. Consists of fluoride of calcium made into wool, and used as cloth between solutions, or, perforated vessels may be lined with it. 1 claim.

6,723. "Improvements in coatings or coverings for electric conductors." C. T. Snedekor. Dated March 30th. The wire or core is preferably of copper, tinned and covered with vulcanised rubber in the usual way. Upon the vulcanised rubber is then applied a special flexible cement or coating composed of magnesia talc, finely ground asbestos, liquid glue, glycerine, bichromate of soda or potash, and where a darkish covering is wanted a small quantity of lamp black. This cement may be intimately mixed in a mortar or like mill. The conductor thus coated may be then taped or braided and run through a bath, or externally saturated with a solution of silicate of soda and alum, and after this has dried a final finish is given by a coating of bisulphide of carbon and asphalt. 2 claims.

14,087. "Improvements relating to incandescence lamps." H. H. Lake. (Communicated from abroad by The General Electric Company, of America.) Dated July 20th. The chief feature of this invention relates to the location of the cut-out which is placed upon the lamp base instead of in the socket as has heretofore been the custom. 2 claims.

16,008. "Improvements in or relating to multiple telegraphy." A. Piedfort. Dated August 24th. Relates to a mechanical arrangement or "auto-distributor for telegraphs" by means of which it is possible to send at one and the same time more than eighty telegraphic communications either in the same direction or in opposite directions through a single wire, each communication going straight to its destination without stopping anywhere or becoming mixed up with any of the others. 7 claims.

17,564. "Improvements in electric accumulators." D. A. Koch. Dated September 18th. Claims:—1. An accumulator having the constituent particles of the active material combined with the electrodes, which latter are preferably made of carbon, as also amongst themselves, by means of plaster of Paris or other similar lime combinations which, through the action of the electrolyte, are turned into plaster, substantially as described. 2. The improved accumulator constructed substantially as described.

18,323. "Improvements in electric batteries." H. H. Leigh. (Communicated from abroad by A. Chevallier, of France.) Dated September 29th. Relates to improvements in electric batteries of the class known as oxide batteries. 3 claims.

18,480. "Improvements in armatures for dynamo-electric machines and electric motors." M. Rahner. Dated October 3rd. Consists chiefly in a combination with a shaft of end plates on the same, a series of core pieces held between said end plates and a separate and independent coil on each core piece. 2 claims.

18,524. "Improvements in indicators, chiefly designed for use at telephone stations, also used for advertising purposes." I. R. Burns and W. F. Burns. Dated October 3rd. The object of the invention is to provide an attractive article that will form a part of the fixtures of a telephone station, wherein all information desirable to the particular station may be compiled upon the flexible sheets therein, thus ensuring privacy. 9 claims.

19,410. "Improvements in rendering electrical fittings luminous in the dark, also applicable to other purposes." A. Firth and G. Y. Ashwell. Dated October 16th. Claim: The manufacture of electrical switches, bell pushes, and other articles of glass or other transparent substance, and coating the same on the inside with luminous paint.

21,324. "Improved electric cables, and method of and apparatus for manufacturing the same." S. Z. de Ferranti. Dated November 9th. Has for its object improvements in electric cables whereby the leads shall be surrounded as much as possible with air, and, in the case of submarine cables which have to stand great pressure, they shall be made capable of withstanding this. Consists in arranging the wire or core in such manner as to come in contact with the enclosing tube as little as possible, by forming it with zig-zags or bends at transverse angles of 120 or 180° from each other or thereabouts, so that it shall only touch the enclosing tube at these angles or bends. 6 claims.

21,628. "Improvements in telegraphy." P. B. Delany. Dated November 13th. The inventor employs a swinging suspended or pivoted coil included in the line, or a branch thereof, and located in a permanent magnetic field of suitable strength. The apparatus resembles somewhat the corresponding parts found in an ordinary Thomson cable recorder. In the new system, however, the swinging coil which carries or actuates a suitable contact maker that controls the local circuit or circuits is entirely without bias and tends to remain at rest in any position to which it may be brought by the action of the current, that is to say, its inertia is the same for all positions and it has no tendency to return to any particular position. 42 claims.

21,707. "Production of ozone and luminosity by electrical means." E. Andreoli. Dated November 14th. Claim: The employment of vacuum tubes, electric lamps, or other exhausted, or partially exhausted, dielectric vessels in the construction of apparatus for the production of ozone, whereby ozone and luminosity or light are simultaneously produced by the silent electric discharge from points bearing electrodes, such as metallic serrated wires, points, &c., disposed outside and in proximity to a vacuum tube or tubes, electric lamps, or the like, internally provided with one electrode or more, substantially as described.

22,255. "Improved means for signalling by electric lamps." H. D. Fitzpatrick. (Communicated from abroad by The Boughton Telephotos Company, of New York.) Dated November 21st. Relates particularly to certain improvements in signal telegraphy, for which Letters Patent No. 16,794 were granted on the 20th day of September, 1892. That invention consisted essentially of a number of electric lights arranged in a continuous line and a number of keys arranged upon a board, each key being marked with a letter of the alphabet and electrically connected with the necessary lights to form the dots and dashes called for by the letter of the key in operation. 7 claims.

22,311. "Improvements relating to storage batteries." E. P. Usher. Dated November 21st. Claims:—1. In a battery plate, the frame having upright bars, or arms, vertically grooved in their outer faces, and formed with edgewise fins, or flanges, extending into the space between the said bars, as described, in combination with non-conducting separators in contact with the opposite faces of said frame, and with a filling of material adapted to become active in the spaces between said upright bars, substantially as set forth. 2. In a storage battery, a series of plates and of interposed separators set in a shallow body of cement or gum, the several plates being supported at a slight distance above the bottom of the vessel containing the gum, substantially as set forth.